STATUS OF BIOTECHNOLOGY IN INDIA

NATIONAL BIOTECHNOLOGY BOARD
DEPARTMENT OF SCIENCE & TECHNOLOGY
TECHNOLOGY BHAVAN
NEW MEHRAULI ROAD
NEW DELHI-110016
REPRINT 1983

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C O N T E N T S

STATUS OF BIOTECHNOLOGY IN INDUSTRY

STATUS OF BIOTECHNOLOGY IN R&D AGENCIES IN INDIA

In order to coordinate the R&D programmes in Biotechnology in different agencies and to provide appropriate directions for future R&D and training programmes for manpower development in areas where there are gaps in internal competence, it becomes essential to formulate the short and long term plan of Biotechnology for the country. Identification of priority areas in the long term plan has to be based on current status of R&D activities in the country.Therefore, the information on R&D activities being conducted/supported in the mamber agencies of the Board was collected. The status report in R&D activities has been compiled by the NBTB Sectt. on the basis of information provided by the various agencies. Details of ongoing research programmes (Agency-wise) in the field of Biotechnology are as follows:

Name of the Agency : DEPARTMENT OF ATOMIC ENERGY

Name of the Institution : BHABHA ATOMIC RESEARCH CENTRE,
(Bio-medical Group)
BOMBAY

Relevant sector of activity: AGRICULTURE, HEALTH, INDUSTRY

GENETIC ENGINEERING:

i) Regulation and cloning of gene(s) for penicillin acylase in E.coli.

Preliminary studies had indicted that in Escherichia coli the gene(s) coding for pencillin acylase is coordinately regulated with the gene(s) controlling utilisation of phenylacetic acid (PAA) (which is also an inducer of penicillin acylase) as a carbon source in E.coli. This facilitated investigation of the genetics of acylase production including genetic mapping of the acylase gene by using the ability to grow on PAA as a convenient genetic marker.However, initial attemps to clone paa (the genes controlling growth on PAA on the plasmid pB R322 using this screening method gave clones which inherited paa unstably. Investigation have continued to the basic genetics of PAA utilisation and acylase production). We find that at least 2 separate genes are required for PAA utilisation. One gene maps near the pro-lac region on the E.coli chromosome.The other gene (gene cluster) appears to be located on a movable genetic element (transposon) as indicated by its variable location in different E. coli K12 strain.

ii) Development of a gene-cloning system in Haemophilus influenzae

H. influenzae is a natural genetic transformation system . However, for uptake, it requires a specific sequence of 11 basepairs in the incoming DNA, 600 copies of which are distributed in its genome. Plasmid RSF 0885 carrying amp^r marker transforms H.influenzae poorly but chromosomal DNA spliced into it raises the transformation level by a factor of 100-1000. Cloned DNA yields are quite high even without chloramphenicol amplification. A new gene cloning vehicle (plasmid J1 was derived from PD7/pD7 cut at 4 sites with Eco RI) which is cut at only two sites by restricton enzymes Eco RI. The two DNA fragments obtained after cutting with Eco RI have a molecular weight of 3.9×10^6 (includes RSF 0885) and 2.5×10^6 (chromosomal DNA). A new library of clones has been produced using pJ1 and Eco RI. The clones are being chacterised.

iii) Rhizobium plasmidology:

Six strains of Rhizobium meliloti were isolated from the nodules of Methi (Trigonella foenum-graecum) and analysed for their resistance to antibiotics. Methodology for megaplasmid isolation is being developed and the plasmids then characterised by agarose gel electrophoresis.

Following observations have been made:

i) Antibiotic resistance: All six strains (Rm-01,04, 06,10,12 and 30) are resistant to ampicillin (100 µg/ml) and neomycin (20 µg/ml). These results suggest the presence of transposons in Rhizobium strains and may also in that case partly account for the information content of plasmid DNA.

ii) Four R.meliloti strains analysed for plasmids each yielded at least one DNA band upon agarose gel electrophoresis. One strain (R_m 04) yielded an additional but sharper fast moving band.

iii) Genetic regulation of nitrogen fixation in Klebsiella pneumoniae

Recent work points to a two stage overall genetic control of nitrogen fixation: (1) Primary regulatory genes linked to glnA (structural gene for glutamine synthetase) prescribe the initial signals in response to concentration of combined nitrogen e.g. ammonia, (2). The products of the gln-linked genes (ntr genes) seem to modulate the expression of nifLA operon (of the nif cluster) which in turn control the transcription of other nif genes. Our work has been aimed at the identification and characterisation of gln a-linked genes.

Photosynthesis:

i) Biochemical and biophysical studies of the chloroplast membrane.

The major emphasis has been to establish the relationship between temperature-induced light emission(thermo-luminescence) from photosynthetic membranes and their electron transport. A technique has been used to demonstrate that photosystem I participates in delayed light emission but that this light is emitted at high temperature. The thermo-luminescena studies have proved information about the energy storage associated with photosynthetic electron transport. In more recent studies the identity of a slow component of delayed light (decaying in seconds) emission with the glow curves has been demonstrated. Other aspects studied include electron transport components, fluorescence

from phtosynthetic membrane organisation of the electron transport chain in the chloroplast membrane, regulation of the excitation energy distribution between the two pigment systems of photosynthesis etc.

ii) Studies on the enzymes of C-3 and C-4 pathway:

The main objective is to isolate and characterise the enzymes involved in CO_2 assimilation by plants. The enzyme ribulose-1-5- bisphosphate carboxylase has been under intensive investigation.

iii) Biosynthesis of chlorophyll

The steps and enzymes involved in the biosynthesis of chlorophyll and heme in higher plants are being studied. The enzyme ALA dehydratase is being purified and characterised . The photoconversion of protochlorophyllide is also being studied.

Plant tissue culture:

Major studies include the experimental control of growth and differentiation. An important contribution is on the Sandalwood plant (Santalum album) where a technique has been developed to obtain hundreds of sandalwood plants from organ cultures. This would enable to clone elite species of sandalwood where quality of wood and oil are demonstrated to be very good. Some of the sandalwood plants obtained in vitro have been successfully established in soil at Nursery at Trombay. By culturing axillary buds of mulberry on a nutrient medium it has been possible to obtain plant development. The regenerated plants obtained in vitro have been successfully reared into mature plants at the Trombay experimental field station. In the case of pineapple, in vitro methods have been standardised for the production of numerous plants from the dormant buds. Success has been achieved in regenerating large number of of plants in organ cultures of mustard. An interesting finding has been that among the regenerants there were yellow-seeded variants with somewhat higher oil content.

In vitro induction of haploid plants through anther culture has been achieved in case of Atropa, Datura, Capsicum and Physalis. Cell cultures of a number of medicinal plants such as Tylophora indica, Atropa Belladonna, Plumbago zeylanica Rauwolfia serpentina etc. have been established and studies have been conducted concerning the regulatory mechanism involved with secondary metabolism of plant tissue cultures. Conditions for large scale experiments using fermenters where use of cell suspension cultures will be made are being standardised. Organ cultures of medicinal plants have been established in view of their superiority over callus cultures in the biosynthesis of secondary plant

metabolites. Considerable efforts are being made to determine the parameters for successful isolation of plant protoplasts in large quantities and to induce regeneration of plant in protoplast culture. Research is also directed towards understanding the factors controlling somatic cell fusion and hybridization in systems such as groundnut, Brassica etc.

ENZYME ENGINEERING:

Immobilised multienzyme complex using the yeast cells

An immobilised multienzyme complex, consisting of invertase, glucose oxidase and catalase could be devised using intact cells of Saccharomyces cerevisiae. The yeast cells were adapted for expression of maximal activities of invertase and catalase. Glucose oxidase from Aspergillus niger was then linked to the cells, using concanavalin A, since the yeast lacked this enzyme. The whole cell flocculate could then be stablised by entrapment in acrylamide polymerised by gamma-irradiation (100 KR). The applicability of the immobilised multienzyme complex for continuous operations was demonstrated for inversion of sucrose and its conversion of fructose and gluconic acid respectively.

Immobilisation of individual enzymes:

The individual enzymes of the above multienzyme complex have been immobilised. Studies of these included exploration of different methods of immobilisation for obtaining maximal yield of the respective enzymes, evaluation of stability characteristics and assessment of kinetic properties.

Regeneration of co-enzymes in vitro:

Stabilisation of alcohol dehydrogenase (ADH) was accomplished by entrapment of anaerobically grown intact yeast cells to regenerate coenzymes (NAD/NADH) in vitro. The system could work efficiently with other dehydrogenases co-immobilised with yeast cells. A two cell system could also be reconstituted using anaerobically grown yeast cells as source of stable ADH along with aerobically grown yeast cells as source of another dehydrogenase, concentrapped in polyacrylamide. The system was stable and efficient for operation several times. Feasibility of sub-cellular organelles like rat liver mitochondria, has also been demonstrated for stabilisation of fumarase for production of L-malic acid.

Hydrolysis of lactose by immobilised lactate in whole cells of Escherichia coli:

Lactase was immobilised using the whole cells of Escherichia coli on hen egg white cross-linked with glutara-

Idehyde. The cells were induced for the maximal expression of the lactate activity using isopropylyl -D- thiogalactoside, prior to immobilisation. The preparation, as tested in a batch reacter, could be used repeatedly for the hydrolysis of milk lactose without any appreciable loss in activity.

RESOURCES UTILISED (MANPWER)

	No.of scientists	No. of technicians
Genetic Engineering	8	3
Photosynthesis	6	2
Tissue Culture	8	2
Enzyme Engineering	3	-

Name of the Agency: COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

Relevant Sector of Activity: AGRICULTURE, INDUSTRY, ENERGY, HEALTH

Name of the Institution: National Chemical Laboratory, Pune

Areas of work: Tissue Culture, Genetic Engineering, Fermentation Technology.

TISSUE CULTURE

a) Clonal Propagation of Fruit trees:

Turmeric: The conventional method of propagation is through the rhizome which is a slow process where only 5 - 10 plants are obtained from one rhizome within a year. In these two varieties "Tekurpeta" and "Duggiralla", the Turmeric Research Stations, Sangli were interested in a tissue culture method for rapid multiplication which was developed whereby over 200,000 plants can be produced from a single shoot in a year.

Tamarind: Trees have been identified which yield about 200 kg. fruits as against the average of 30-50 kg. per year. This problem was undertaken to multiply high yielding trees since the only available method for propagation of tamarind is by seeds where plants show great variation.

Pomegranate: The common method of propagation is by seeds. Due to a marked variation observed in plants raised by seeds, vegetative methods such as rooting of hard wood cuttings or air layering are preferred. By air layering only 70-100 plants can be obtained from one mother stock plant. By tissue culture a method has been developed for mature trees of two varieties, Ganesh - I and Muscat by which a few thousand plants can be produced from one explant in a year.

Apple: Apple trees are usually multiplied by grafting the fruiting cultivar into a root stock. Regeneration from meristem tips promises to be a quicker and cheaper method and can also produce pathogen free plants. Self rooted trees from good cultivars would also avoid graft incompatibilities and diseases introduced during propagation. Regeneration of plants has been obtained with two apple varieties, and the plants grown in field.

b) Clonal propagation of forest trees:

a) Teak:

Vegetative methods like grafting, budding, air layering and rooting of cuttings have not been very successful. Plants propagated by seeds also rarely breed true. By tissue culture a method was developed for the elite, mature trees by which about 500 plants can be produced from one vegetative bud in a year.

b) Eucalyptus:

This species is important both for the oil content in the leaves and for its soft wood used as fuel. In E. citriodora plantations trees having high oil contents have been identified. The progeny raised by seed from these high oil yielding trees were found to show very wide variation and barely 2-3% of the total resembled the parent trees. A tissue culture method was developed for these high oil containing trees, by which about 200,000 plants can be produced for a single explant in a year.

Cereals:

Wheat

Two plants isolated from a culture of wheat NI 917 were found to show striking variation in yielding grain. To test the potential of these plants, seeds obtained were grown over successive generations in field trials.

Plantation Crops:

Sugarcane:

Maharashtra is one of the major sugar producing states in the country where the major area under sugarcane is planted with a high yielding sugarcane variety C0-740. This variety is highly infected with sugarcane mosaic virus, which is characterised by mottling of the leaves and the presence of transluscent yellow patches. A tissue culture method was developed at NCL and over 100 virus-free plants were produced through meristem culture and transferred to the field.

Banana:

Robusta and Basrai are two cultivated varieties in Maharashtra and Tamil Nadu. Bunchy top, a viral disease which affects Robusta plants is characterised by stunting and curling of the young leaves forming

a floret at the top. This greatly affects fruit setting. Basrai plants are susceptible to chlorosis, a viral disease in which the central core of the stem starts blackening resulting in death of the plant. Both these diseases are seriously affecting banana plantations as not for obtaining virus free plant shoot tips. About 60 plants are undergoing field trials.

Cardemom:

High yielding elite clones of cardamom have been identified by the Cardamom Board, Kerala. Propagation by conventional vegetative methods are very slow and seed raised plants are heterogeneous. Cardamom is also highly susceptible to a viral disease known as Katte disease for which no control methods are available. Tissue culture can be used both for isolation and multiplication of identified virus free plants and elite clones. By tissue culture, rapid methods were developed for two high yielding varieties supplied by the Cardamom Board, and some plants produced are undergoing field trials.

Carica papaya:

A hybridization programme was initiated at the Agricultural College, Poona to induce papaya leaf mosaic virus resistance in C.papaya by crossing C.papaya with C.cauliflora, following conventional breeding methods. In all their attempts the embryo failed to grow beyond 60 days and the mature fruits that developed were found to contain no well developed seeds. By culturing 45-50 days old hybrid embryos on synthetic media in tissue culture about 5% of these embryos could be grown to maturity and germinated.

BASIC STUDIES IN TISSUE CULTURE:

Differentiation - a biochemical approach:

By using different tissue cultures, studies are in progress to examine (1) endogenous hormone levels; (2) changes in the enzyme patterns; (3) changes in the isoenzyme patterns and (4) changes in the protein patterns during the transition of the callus tissues to the organised state.

Differentiation - molecular approach:

A clear understanding of differentiation phenomenon could hasten the progress of the application

of tissue culture to vegetative propagation, which at present is a hit and miss procedure.

1. Using inhibitors of DNA methylation, attempts to reactivate certain genes could be made. It is proposed to use such analogs to investigate the regulation of differentiation in plant tissue culture.

Preliminary studies have been initiated using differentiation and non-differentiating callus tissues from different plant species.

2. A second approach being made is in studying the DNA reassociation kinetics from the callus and differentiating cultures.

Differentiation - Scanning Electron Microscope approach

A third approach towards studying the events leading to differentiation is being made by the use of scanning electron microscopic studies, with differentiating and non-differentiating callus tissues. By these observations morphological changes occuring at the surface of the cells during their conversion from the non-differentiated to the differentiated state will be studied.

The results of these studies will be coordinated with the biochemical, physiological and molecular biological results and may throw light on the phenomenon of differentiation in general.

Immobilisation of plant cells:

A new approach to secondary product biosynthesis from tissue culture is through immobilised system of plant cells. Using this approach attempts are being made to produce useful secondary metabolites which are normally obtained in very minute quantities or are very expensive. Examples of such plant products are the two alkaloids vinchristin and vinblastin from Vinca rosea

GENETIC ENGINEERING:

a) An integraded project on production of restriction endonucleases and other reagents.

This programme is receiving support from CSIR/DST and is coordinated by CSIR Centre for Biochemicals in Delhi. The main objective is to produce restriction endonuclease specifically required for Genetic research.

b) Modification of yeast genome for increased alcohol production by gene manipulation.

In order to modify the yeast genome the following aspects are being studied:

i) Pertaining to the pathway/enzyme systems in the bioutilisation;
ii) Pertaining to utilisation of biomass products other than hexose materials to meet energy requirements; and
iii) Pertaining to environmental adaptation like tolerance to ethanol.

c) Cloning of Cellulase genes.

Preliminary studies have been carried out on the DNA structure and DNA sequence analysis in these species. Methods have been standardised to isolate DNA of high molecular weight from all the three fungal species which is a prerequisite for Genetic Engineering work. Various studies such as restriction endonuclease mapping of total DNA and DNA sequence organisation are in progress.

d) Detection and characterisation of plasmids in bacteria and fungi of industrial and agricultural importance.

A few standard plasmid vectors like pBR322 are routinely prepared in the laboratory, investigations will be undertaken to screen some of the microorganisms available in the culture collection at NCL for plasmid-like elements. Further, in association with the expertise available at NCL in the field of genetic engineering, applications of new plasmids in strains improvements and genetic studies will be looked into.

From plant cells and plan specific tumours, plasmids will be isolated and characterised. Using in vitro recombination techniques, new DNA molecules will be engineered from the nonpathogenic part of plasmids and the fragment of a foreign DNA whose expression could be desirable in the new environment. Such a hybrid plasmid could be generated for functions like nitrogen fixation, specific enzyme expression (like glycogen synthetase) etc.

With the help of the National Collection of Industrial Microorganisms at NCL,efforts will be made to maintain such isolates of plasmids and plasmid-derived new varieties of microbes for national access.

e) Gene manipulations in Plants:

Clones have been obtained in the course of the last six months from two plant species namely Pearl millet and Finger millet. Shot gun procedure was used to clone these plant DNAs in E.coli. Preliminary studies, involving colony hybridization using labelled RNA, showed that the r RNA genes were cloned. Work is in progress to characterise the clones.

Shot gun approaches are very inefficient considering the huge genome size of plants in general. It is therefore, planned to isolate the specific genes by isolating mRNA which can be used to synthesise C DNA using reverse transcriptase. C DNA, in its turn, will be used to isolate structural genes from libraries of nuclear DNA.

For the integration of exogenous DNA into host plant cell genomes, tumor inducing plasmids (Ti) for Agrobacterium tumefaciens will be used.

f) Cloning of plant genes and their use in analysis of chromosome structure. DNA sequence organisation and gene splicing mechanism.

Extensive molecular biological work on plant genomes has been carried out at NCL. Over thirteen plant species belonging to Leguminosae and Gramineae were characterised with respect to DNA structure and DNA sequence organisation.

Based on these data, it was observed that plant genomes exhibit extreme variations in the arrangement and length of repeated and single copy DNA sequences. A new, rapid and simple technique of chromosome banding was developed. This technique unlike the present technique is of general applicability to a large number of plant species including those having small chromosomes, close correlation was observed between the various cytological and molecular biological parameters in different plant species.

g) Molecular basis of differential gene expression during development and growth of plants.

The problem of differentiation will be studied in plantcells, grown in vitro as well as in vivo. Similar to bacterial cells, cultured plant cells offer a unique opportunity for studying eukaryotic genomes under controlled conditions.

a) Biochemical analysis of chromatin structure during differentiation, organisation of chromatin will be studied as histone-nucleic acid fraction and nonhistone nucleic acid fraction. Proportion of histone and nonhistone proteins, and variation of their contents, at different developmental stages will be established by standard biochemical techniques including gel electrophoresis.

b) Transcriptionally active and inactive chromatin will be isolated from chromatin and these will be analysed for their DNA molecular weight, DNA base sequences and for presence of repeated fractions during differentiation. Correlation of these values with NDA content will be ascertained to understand the degree of DNA amplification during differentiation.

c) Analysis of base sequence changes during differentation will be attempted by endonuclease digestion to secure a qualitative and quantitative picture of changes.

d) The extent of methylation and the distribution of 5 methyl cytosine will be studied in transcriptionally active and inactive chromatin fractions. The restriction enzymes HpaLL and MpL will be used for this purpose.

e) RNA are single copy DNA hybridization experiments will be carried out to understand the extent to which expression of structural genes is regulated during differentiation.

ENZYME ENGINEERING & ALCOHOL FERMENTATION

i) Immobilised penicillin acylase

Two immobilised penicillin acylase system have been developed at NCL in collaboration with Hindustan Antibiotics Ltd., Poona (HAL). The research laboratories of HAL had isolated microbial strains suitable for the production of both type I and II pencillin acylase. The main objective of the work at NCL was to immobilise these enzymes from relatively dilute solutions without any preliminary concentration or dewatering steps. It was also necessary to use a cheap support since the enzyme preparations were relatively crude preparations purified only partially. In one of the immobilised enzyme systems which was developed, the enzymes were covalently attached to a modified support. The enzyme preparations were immobilised by coupling to CNBr-activated alkali-treated cellulose. A high percentage of about 85-100%

of enzyme activity was attached from partially purified soluble enzyme preparations. The immobilised system shows negligible diffusional restrictions and is free of substrate or product inhibition even at relatively high substrate concentrations. The preparation has good storage and operational stability.

The preparation of immobilised enzyme was optimised and scaled up in collaboration with HAL. The firm has set up a plant for the production of 6-MFA (35 tpa) with NCL advise on the design. The production plant for making immobilised penicillin acylase has been set up by the firm on the basis of a complete design of a commercial plant given by NCL.

The usefulness of the immobilised penicillin acylase system developed by NCL was established initially in HAL laboratory and 100 L pilot scale trials and final in the 1000 L production plant reactors at HAL. All trials were over atleast 20 cycles of batch operation and the conversions yield and quality conformed uniformly to the expected values. The industrial application of immobilised enzymes is relatively recent even in the developed countries and the present successful production scale trials are the first in this country.

Studies have also been carried on the different configurations of the immobilised enzyme reactors for 6-APA production with the objective of designing an optimum reactor when the scale of operation in the plant would be further increased. A continuous operation in the plant would be further increased. A continuous stirred tank reactor was studied for this purpose and it was found that the size of the reactor required would be excessively large and uneconomical. To investigate which type of reactor configuration would be suitable, the kinetics of the reaction were investigated and the various rate and inhibition constants determined. From these results, it was concluded that the batch reactor would be the appropriate design. The biosynthetic pencillin which are used as substrates for the preparation of 6-APA, are relatively unstable in solution and degrade over the prolonged period required for complete hydrolysis when low activity enzyme preparations are used. The use of purified enzyme attached to carriers can advantageously reduce the reaction time and minimise substrate and product losses due to spontaneous decomposition. Conditions were therefore established for the purification of a type II pencillin acylase from Kluyvera citrophila. The purified enzyme has been covalently attached to controlled-pore ceramics of TiO_2 and Al_2O_3 in almost quantitative yield and the immobilised enzyme preparations have been shown to have high operational stability.

(ii) Sorbitol oxidation to sorbose:

Immobilized A.subozydans cells were shown to oxidise sorbitol to sorbose and recoveries of the product were almost quantitative. The re-use potential of the system was limited under agitation and aeration requirements.

(iii) Immobilised glucoamylase:

Glycoamylase which catalyses the hydrolyses of soluble starch to glucose and finds extensive use in the commercial production of dextrose was used as a model system for the development of novel immobilised enzyme systems. In these the enzyme was immobilized on inorganic supports like ferrite by with the cross-linked substrate. Such systems permit recycling of carrier with fresh enzyme charge without apparent decrease in enzyme loading on the carrier. The magnetic support also permits easy recovery from viscous slurries.

(iv) Continuous conversion of molasses to ethanol using immobilized yeast cells.

A novel method for obtaining open-pore polysaccharide or protein beads with entrapped yeast cells was developed. Ethanol productivities of yeast cells entrapped in such a porous gelatin matrix has been shown to be 2 to 3 times higher than the values reported in the literature. Isolates of ethanol-tolerant yeasts immobilized in the gelatin system have been shown in Laboratory studies to be stabled over a few month of continuous operation.

(v) Basic studies in enzyme chemistry

Active work in this basic area of research has been carried out in the Biochemistry Division at NCL since its inception.

Several enzymes involved in intermediary metabolism e.g. fungal aldolase; bacterial glycerol dehydrogenase; brain hexokinase; NA Dase and acetylcholine esterase; fungal acylases; bacterial nitrate and nitrite reductases; citrate lyase; citramalate hydrolyase; transaconitase; hydrogenase; phytase; amylase; proteases and enzymes involved in terpene metabolism; plant acylphosphatase; several proteases (and their inhibitors) have been purified and characterised for the first time in this Laboratory.

Detailed studies on the structure and mechanism of action of two important bacterial enzymes, citrate lyase and nitrite reductase have also been carried out.

The experience gained in these studies have been applied to the solution of practical problems such as immobilization of industrial enzymes, isolation and cha-

racterization of cellulases required for enzymic hydrolysis and cellulose to glucose and other fermentable sugars.

(vi) Basic studies on reaction engineering of enzyme and microbial systems.

Mathematical modelling of the effects of internal and external diffusional resistances on the apparent stability of immobilised enzyme catalysts has been examined. The temperature optimum of immobilised enzyme reactions is shown to be unaffected by diffusion.

However, the apparent stability with respect to temperature and time is enhanced. The effects of deactivation on the behaviour of immobilised enzyme reactions have also been modelled in fixed and fluidized bed reactors. Further, a generalised optimum temperature operations criterion for deactivating immobilised enzyme batch reactor has been formulated. Modelling has also been done on enzyme deactivation involving pH.

B. Biotechnology of cellulose utilization

(i) Screening of fungal isolates

In an extensive screening programme undertaken at NCL, several hundred cultures isolated from soil, plant detritus and other naturally decomposing lignocellulosic habitats were examined for cellulase and for biomass production. Two promising cultures, a Penicillium funiculosum and Sclerotium rolfsii were isolated which grew rapidly on cellulosic substrates with extracellular release of high exogluconase, endogluconase and B-glucosidase activities. A penicillium janthinellum isolate was also obtained which grew rapidly in the presence of ammonium sulphate/urea on rice straw which had been alkalia utoclaved and washed.

(ii) Conversion of cellulose to glucose/ethanol

A mutation programme has been initiated with the P.funiculum and S.rolfsii isolates for strain improvement to achieve higher cellulase activities and productivities. Following mutagenesis with physical and/or chemical agents, the colonies were selected on the basis of a plate clearing assay on cellulose agar containing colony restrictors. Several mutants have been selected including some which show morphological variations. Strains showing markedly enhanced activities in shake flask experiments are being studied in instrumented fermentors.

Experiments have been conducted in instrumented fermentors to maximise cellulase activities and productivities in batch cultures of P.funiculosum. Maximum filter paper activity of 3 IU/ml and productivity of 30 IU/l/h have been obtained with the wild strain, while a one step UV mutant has yielded 50% enhanced activity.

Saccharification experiments with cane bagasse steam treated under relatively mild conditions gave almost quantitative hydrolysis of cellulases with P.funiculosum cellulose.

Two Neurospora strains have been found to give direct conversion of glucose, cellulose and hemicelluloses to ethanol.

(iii) Conversion of cellulose to microbial biomass product

The conversion of alkali-pretreated rice straw to microbial biomass product with the P.janthinellum isolate was studied in shake flask and in laboratory fermentors. Mild pretreatment conditions designed to minimise pollution problems and cheap commercial grade nutrient supplements were found to be adequate for obtaining microbial biomass with 20 - 22 % protein. Preliminary feeding trials on mice have shown absence of any toxicity.

RESOURCES UTILIZED (MANPOWER):

Genetic Engineering : 13
Alcohol Fermentation: 29
Tissue culture : 32

Name of the Institution: Indian Institute of Chemical Biology, Calcutta.

Areas of Work: Genetic Engineering, Enzyme Engineering, Immunotechnology

GENETIC ENGINEERING

Analysis of regulation of gene expression in V. cholerae.

The following studies are being undertaken:

a) Analysis of regulation of gene expression in V. cholerae; construction of gene bank and cloning of the B-subunit of the toxin molecule; ii) development of toxin isolation and assay system by affinity chromatography; iii) analysis of compounds associated with virulence and immunity and iv) characterisation of cholera bacteriophages.

b) A plausible correlation among toxicogenicity and several metabolic functions in V. cholerae has been suggested from studies on DNA repair, certain enzymes and phage infection and transfection.

IICB is also participating in the integrated programme of production of restriction endonucleases.

ENZYME ENGINEERING & FERMENTATION TECHNOLOGY

a) Enzyme engineering and its application in Medicine.

b) Isolation and purification of carbohydrates of biochemical and industrial importance for mushroom fermentation.

c) Solid culture technique for mushroom fermentation.

Solid culture technique for mushroom fermentation on agricultural waste has been developed and sylanase, amylase and cellulose could be obtained in high yields; insulinase has also been identified in the medium during mushroom fermentation.

IMMUNOTECHNOLOGY

a) Development of cheap, rapid and easy immunoassay methods especially for diagnostic purposes.

b) Characterisation of surface antigen of Leishmania donovani and evaluate with regard to their protective nature and serodiagnostic applicational detail, elucidation of the structure function relationship of the antigenic polysaccharides, cloning of genes for membrane and seantory proteins to study the biochemistry and molecular biology for the parasitic with a view to understanding the mechanism of drug resistance, for developing national approach to chemotherapy; development of improved chemotherapeutic agents for Kalaazar and improved drug delivery system to clarify the biology of host-parasite relationship.

c) Enzyme immunoassay techniques have been developed for circulating myoglobin and astriol.

d) Expertise has been developed for sero-diagnosis of Kalaazar.

e) Development of enzyme immunoassay techniques for drug and steroid hormones.

f) Analytical serology of Neisseria gonorrhoeae: cell surface antigens.

g) Surface components of V. cholerae, associated with virulence and immunity.

h) Adjuvant and carrier properties of liposome.

RESOURCES UTILIZED (MANPOWER)

Genetic Engineering - 11

Enzyme Engineering & Fermentation Technology - 5

Immunotechnology - 16.

Name of the Institution: Central Drug Research Institute, Lucknow.

Areas of Work: Genetic Engineering, Fermentation Technology, Immunotechnology

GENETIC ENGINEERING

Improved yield of microbial products

Studies have been taken up in project entitled "Isolation, characterisation and classification of R-Plasmids". Different drug resistant strains collected from hospital sources have been isolated. Further work on plasmids isolation, conjugation etc. will follow with a view to developing industrially important strains.

FERMENTATION TECHNOLOGY

a) Utilisation of biomass as a source of energy (Joint project with NBRI).

Work is in progress on utilisation of biomass as a source of energy. The study comprises of

(i) growing biomass in unfavourable soil conditions which ultimately reclaim the soil and at the same time produces biomass as a source of energy. This is being done by National Botanical Research Institute, Lucknow.

(ii) Production of alcohol from the above biomass. This part is being studied at CDRI, Lucknow. Studies are in progress to isolate alcohol resistant strain of yeast for optimising yield. Novel fermentation techniques like vacuum fermentation, high temperature fermentation are being pursued with a view to increasing productivity.

Industrial Microbiology:

Studies are in progress in the production of known and new antibiotics, microbial transformation of steroids, produc-

tion of organic acid, amino acid, glycerol, 1-phenyl acetyl carbinol which is an intermediate fro L-ephedrine hydrochloride etc. Studies are also in progress in refining of molasses, an important raw material in fermentation and chemical processes to increase yield and reduce recovery and purification expenses. The studies follow the sequence of shake flask, bench scale and pilot plant scale fermentation. Economically viable and industrially feasible processes are further analysed for making project engineering. Help is rendered to user industries by way of designing and sizing of Pilot Plant and industrial production units.

b) Manufacture of L-phenylacetyl carbinol

Process for manufacture of L-phenylacetyl carbinol by fermentation and its subsequent chemical conversion to L-ephedrine HCL has been successfully developed and scaled up. Various manufacturers have taken the process. One firm has already gone for industrial production.

c) Production of antifungal antibiotic

A process for the production of antifungal antibiotic UNI-36 by fermentation has been developed and patented. One leading industry is planning for its production and marketing.

d) Microbial transformation of progesterone

Encouraging results have been obtained in microbial transformation of progesterone to 11 -hydroxylated product. Transformation yield of about 80% at 15 g/l substrate concentration has been achieved. This is an important intermediate for synthesis of antiinflamatory steroids.

e) Microbial conversion

A process for microbial conversion of 3-metnoxy-8, 14 seco 1,3,5(10), 9(11) gona tetraen 14, 17-dione to its 17/3 hydroxy derivative has been developed. This is an important optically active intermediate in the chemical synthesis of antifertility steroids.

f) Production of citric acid

A process for the production of citric acid from black strap molasses has been developed. The process is under scale up studies and economic evaluation.

g) Production of glycerol

A process for the production of glycerol by fermentation has been developed.

IMMUNOTECHNOLOGY

a) Immunological studies of Malaria. The following aspects are being studied.

i) Immunity and immunoprophylaxis against malaria.

ii) Development of new adjuvants for vaccine, serodiagnosis of malaria, immune mechanism, interaction of contraceptive steroids and malaria.

b) In vitro cultivation of filarial parasites culture of different stages of filarial parasites, both animal and human in chemically defined and cell culture media - for collection of metabolic and somatic antigen. Adequate supply of antigen - both metabolic and somatic is the prime requirement for serodiagnosis, immuno-diagnosis and immuno-prophylactic studies. For understanding mode of drug action in vitro culture is necessary.

RESOURCES UTILIZED (MANPOWER)

Genetic Engineering - 7

Fermentation Technology - 28

Name of the Institution: Indian Toxicological Research Institute, Lucknow

Areas of Work: Immunotoxicology

IMMUNOTOXICOLOGY

Immunotoxicological evaluation of agate dust or mined dust was carried out. Both the particulate dust produced acute inflammatory reactions at early periods in the lung followed by marked phagocytosis and fibrotic reactions at later periods. The particulate substances also produced degeneration necrosis in the regional lymph nodes. Effect of agate dust on primary immune response in rats was also investigated. Preliminary serum proteins studies in agate workers from Kambhat (Gujrat) indicated the evaluated levels of 1 gh with slight alteration in 1 gA and 1 gM in these workers.

Immunotoxicological studies of industrial and environmental chemicals.

To develop and standardise some of the techniques of cell mediated and humoral immunity with a view to assess the immunotoxic effects to coal mine dusts in laboratory animals.

RESOURCES UTILIZED (MANPOWER)

Immunotoxicology - 8

Name of the Institution: National Botanical Research Institute, Lucknow

Areas of Work: Tissue Culture, Fermentation Technology, Photosynthesis

TISSUE CULTURE

1. Hundreds of samples of Dioscorea floribunda, Kallstroemia pubescens, Costus speciosus, Trigonella foenum-graecum and Solanum khasianum had been cultivated in field and in-vitro, and analysed for diosgenin contents.

2. Details of the processes of multiplication of variants produced from leaf callus of D. floribunda as well as for its in-vitro induced tetraploids have been worked out.

3. Somatic calli of D. floribunda have been grown at a prolific rate on agar-media.

4. Excise root culture of S. khasianum has been established and demonstrated to re-generate plants even in long term culture.

5. Variants with high seed yield of fenugreek, tuber yield of D. floribunda, and rhizomes yield of C. speciosus have been selected from mutagen treated population.

6. Effects of gamma irradiated rhizomes of one hundred samples of C. speciosus and two hundred samples of D. floribunda were studied for diosgenin culture.

7. About 50 samples of K. pubescens and 100 samples of D. deltoidea were chemically analysed.

8. About 430 samples of plant material from Western Forest regions were chemically screened, of which 72 samples gave the presence of alkaloid, 91 of flavonoid and 84 of Saponins.

PHOTOSYNTHESIS

1. Production technology for Spirulina platensis in sewage is at advance stage of development and is being tested and standardised on a pilot plant scale.

2. The production ponds have an area of about 450 sq.m. divided into four partitioned tanks to control and manipulate the cellular density of the alga.

3. Present rate of biomass production is 7-8/m^2/day.

4. The cultivation process has been established and recycling and recharging schedule standardised.

5. Pond effluents and filtrate mixed with fresh water are used for fish-rearing as a biproduct of the waste cycling systems.

6. Reclaimed water from the fish tank is utilised for irrigation purposes.

ALCOHOL FERMENTATION

1. Planting of trees has been done.

2. Promising strains have been introduced.

3. Performance of 18 varieties of sugarbeet on alkali soil has been studied for their yield, sugar percentage and conversion into alcohol.

4. Sweet Sorghum has been grown for seed multiplication.

Name of the Institution: Central Food Technology Research Institute, Mysore

Areas of Work: Fermentation Technology

FERMENTATION TECHNOLOGY

a) Studies on immobilised enzymes (with special reference to polyphenol oxidase and tannase for the preparation of instant tea and glucose isomerase, amylase, -glucoamylase for high fructose systems.

b) Utilisation of agricultural residues and Agro-industrial wastes for the production of commercially important biochemicals (enzymes, alcohols, organic acids etc.)

c) Scale up studies on fungal protease (Microbial rennet) by solid state fermentation and its modification for use in cheese making.

d) Scale up studies on the production of glucose isomerase by submerged fermentation.

e) Improvement in fermentation process for economic production of liquid fuels and other yeast derived product.

f) To develop indigenous technology for the production of gibberellic acid by fermentation.

Name of the Institution: Regional Research Laboratory, Jammu

Areas of Work: Fermentation Technology

FERMENTATION TECHNOLOGY

a) To develop technology for the conversion of steroids to "hydroxy steroid which can be chemically converted into corticosteroid".

The work on microbial conversion of progesterone to "alpha-hydroxy-progesterone have been completed upto laboratory fermenter level to a substrate concentration of 40 g/l. The conversion yields are of the order of 80%. Further work to increase the substrate concentration conversion and scale up to larger fermenter is being taken up.

NAME OF THE AGENCY : INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RELEVANT SECTOR OF ACTIVITY : AGRICULTURE

NAME OF THE INSTITUTION : CENTRAL PLANTATION CROPS RESEARCH INSTITUTE, KERALA.

AREAS OF WORK : TISSUE CULTURE, FERMENTATION TECHNOLOGY

TISSUE CULTURE

Attempts to induce rooting in cultured explants and producing viable plantlets are in progress. Callus has been induced from immature stem and leaf-base tissues excised from seedling and adult palm meristematic regions. Culturing of mature embryos has been taken up to produce viable plants, and attempts to induce multiple shoots, particularly from immature embryos, are in progress. Culture of leaf and root tissues has also been taken up in order to obtain a continuously growing callus and to differentiate embryoids and plantlets from the callus, as has been reported in oil palm for clonal multiplication of elite palms.

Similarly, in turmeric, a technique has been developed for rapid, large-scale multiplication of a high yielding, high curcumin containing clone. The tissue cultured plantlets have been transferred to polybag nursery in glasshouse and harvests of upto 135g/plant of fresh rhizome have been realized, eight months after transfer.

Protoplast Culture

Development of an efficient embryo and tissue culture technique has been attempted for the rapid and efficient transportation of germplasm in bulky-seeded species like coconut and in vegetatively propagated crops like ginger, turmeric, pepper and cardamom. In view of quarantine problems and the high cost of transporting bulky seeded materials like coconut, embryo and tissue culture will accelerate germplasm collection and exchange.

A tissue culture sytem is being standardized for screening germplasm against diseases and pests, by using the toxins released by pests and pathogens. Such techniques will be ideal and also necessary in screening for resistance against coconut root (wilt) disease, coconut leaf eating caterpillar, tea mosquito in cashew, rhizome rot in ginger, 'katte' diseases of cardamom and pepper wilt.

Cell Cloning and protoplast culture techniques will be also useful in these crops in order to use this in genetic engineering experiments to generate additional variability especially in crops possessing a narrow genetic base such as cloves for instance, in resistance breeding for quality.

Induction of haploids through anther and pollen culture is being attempted in these crops in order to produce isogenic lines for generating diverse heterotic combinations

FERMENTATION TECHNOLOGY

Microbiological studies with reference to cacao fermentation and biodegradation of lignocellulosic wastes.

The cacao fermentation work was initiated in only 1981 while the biodegradation studies on selected agricultural wastes were initiated in 1974. Both these studies require to be intensified, particularly those on biodegradation of of linocellulosic wastes.

NAME OF THE INSTITUTION : INDIAN INSTITUTE OF HORTI CULTURAL RESEARCH, BANGALORE

AREA OF WORK : TISSUE CULTURE

TISSUE CULTURE

A) Induction of Androgenic Plants

Experiments were conducted with a view to induce androgenesis in solanaceous plants like brinjal, Capsicum annuum, Physallis spp. , Petunia and tomato. Anthers of Petunia axillaris at the uniucleate stage of pollen development produced plantlets, activity growing callus tissue has been induced from cultured anthers of Petunia Hybrida, which differentiated shoot buds. Anther cultures of brinjal yielded only callus tissues.

B) Clonal Propagation

Banana: The possibility of clonal propagation of Robust banana (Musa Acuminata L.)was explored. Rhizome tips containing apical and lateral buds were found to be suitable material for plantlet production in vitro Excised rhizome tips with the youngest leaves and apical bud produced only one plant. However, rhizome tips with several leaf bases enclosing the axillary buds regenerated multiple plantlets in vitro. Individual shootlets when separated and sub-cultured on the same medium produced a new crop of plantlets. Rooted

plantlets obtained from both the types of explants have been successfully transplanted to soil and grown to maturity.

Jack Tree: Cultured shoot tips from the juvenile shoots of a thirty year old jack tree (Artocarpus heterophyllus)resulted in multiple shoot induction through stimulation of axillary buds. The shootlets grew as rootless shoots in culture.

Pineapple: Differentiation of plantlets has been obtained in hybrid (kew x Queen) embryo callus of pineapple. Embryonal callus was initiated by planting seeds containing the hybrid embyros. On an average, 20-25 fully developed planlets can be obtained from single hybrid embyro. Regeneration of shoot buds and multiple shoots resulted from the cotyledon and shoot tip explants.

Onion: Callus from radicular end of surface sterilised seeds of onion, differentiated into shoot buds. Individual shoots, when cultured, resulted in fully grown rooted plants.

RESOURCES UTILIZED (MANPOWER):

TISSUE CULTURE: 2

NAME OF THE INSTITUTION : CENTRAL TUBER CROPS RESEARCH INSTITUTE, TRIVANDRUM

AREAS OF WORK : TISSUE CULTURE, FERMENTATION TECHNOLOGY,PHOTOSYNTHESIS.

TISSUE CULTURE

Cassava: Reduction in cassave yields upto 10-15% due to mosaic virus disease, have been recorded. Attempts are being made to obtain cultivars free from this disease, through meristem culture.

FERMENTATION TECHNOLOGY

Fermentation of cassava and sweet potato for producing industrially important products like alcohol, glucose isomerase, and glucamylases,acetone and butanol.

Fermentation of cassava and sweet potato,excellent sources of starch is being tried. These two crops posses

high rates of productivity. It would be possible to utilise cassava and sweet potato fermentation for producing industrially important products like alcohol, glucamylase and glucose isomerase required in industry and pharmaceutical manufacture. Techniques for saccharification and fermentation of starch for ethanol production using acids, enzymes and acid-enzymes have been standardised. Identification of efficient fungal, bacterial and actinomycete cultures for saccharification and production of enzymes have to be done.

PHOTOSYNTHESIS

Photosynthesic sutides in tropical tuber crops with reference to carbon dioxide fixation, translocation efficiency and identifying cultivars with lower rates of photo-respiration.

Tropical tuber crops are known for their high levels of production potential. Some basic studies on the rate of photosynthesis and dry matter accumulation have been studied

NAME OF THE INSTITUTION : INDIAN VETERINARY RESEARCH INSTITUTE, IZZATNAGAR.

AREAS OF WORK : IMMUNOTECHNOLOGY, GENETIC ENGINEERING

IMMUNOTECHNOLOGY

Work on the development of suitable immunoprophylaxis against important diseases such as enquine abortion would be continued and similar other diseases like internal parasite and blood protozoan diseases etc. would be intensified.

GENETIC ENGINEERING

Viral genetics including gene splicing and its use in vaccine production

a) Gene splicing has been used for developing virus vaccines using E.coli such as in case of Foot and Mouth Disease. Similar techniques could be utilized in case of manufacture of other virus vaccines.

b) Work on the development of suitable immunoprophyllaxis against important diseases such as equine abortion would be continued and similar other diseases like internal parasite and blood protozoan diseases etc., would be intensified.

INDIAN VETERINARY RESEARCH INSTITUTE,HEBBAL

a) Studies on FMD viral Mutation, recombination and genetic mapping with an objective to develop vaccine are being undertaken.

b) To study virus cell association at genetic level and its implication to neoplastic state.

c) To study in vivo studies of cells transformed by the viruses and their immunological status and role of chemicals like interferon in tumour rejection.

d) To study and apply monoclonal antibody technology in the study of viral diseases of animals.

RESOURCES UTILIZED (MANPOWER):

Genetic Engineering: 15

IMMUNOTECHNOLOGY : 11

NAME OF THE INSTITUTION : NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL.

AREAS OF WORK : FERMENTATION TECHNOLOGY

FERMENTATION TECHNOLOGY

Biconversion of ligno-cellulosic wastes for enriched protein (SCP) as livestock feed.

The sugar cane bagasse was fermented with a cellulolytic mold Aspergillus terreus GN_1 under optimum cultural and nutritional conditions for 3 days and the crude protein content was increased from initial 2% to 14%. However, the hot alkali treatment of bagasse as substrate, increased the G.P. percent in the SCP process. Alkali treated bagasse yielded a SCP product of enriched protein and the cellulase enzyme which is economically viable.

IMMUNOTECHNOLOGY

Immunology - its role in immunodiagnosis and treatment through development of suitable vaccine:

Salmonella abortus equi has been known to be a major etiological agent in the equine abortion in India. Some of the vaccines currently used for immunoprophylaxis against S. abortus equi have been found to be ineffective in control of the infection in the equines. Studies were, therefore,

carried out to develop an improved technology to isolate the ribosomal antigens and to use them for immunoprophylaxis and to evaluate their protective role.

Salmonella abortus equi (Strain No.E.812),isolated from cases of equine abortion, was used for this study. Ribosomes were isolated and fractionated by salt precipitation and ultracentrifugation. Their electrophoretic pattern showed various protein fractions. Ribonucleic acid was estimated in order to check the purity of the sample. The antigen was injected to mice and this gave significant level of protection against the S. abortus equi infection. A single precipitation line was seen on immunoelectrophoresis against its antiserum from rabbit. Good antibody litre in rabbit showed the involvement of humoral response. Role of cell mediated immunity is presently being studied.

Similarly, work on development of suitable immunoprophylaxis against other important diseases, especially internal parasites and blood protozoan diseases such as theileriasis and Babesiasis is in progress.

NAME OF THE INSTITUTION : INDIAN AGRICULTURAL RESEARCH INSTIUTE , NEW DELHI

AREAS OF WORK : PHOTOSYNTHESIS,TISSUE CULTURE, GENETIC ENGINEERING

PHOTOSYNTHESIS

Regulation of nitrate assimilation in plants by sunlight and photosynthesis

It was observed that light is required for the production of nitrate in the leaves and the process stopped immediately in the absence of light.Work done at the IARI has shown that this regulatory mechanism operates through inhibition of mitochondrial oxidation of NADH.

Biochemical role of photo-respiration in plants

Recent work done at the Institute has shown a biochemical role for photorespiration, which has been considered so far as wasteful process, in the sense that it provides carbon for the citric acid cycle during active photosynthesis.

TISSUE CULTURE

Protoplast culture

The work in this area was done with the ultimate objective of parasexual genetic manipulation in higher plants at the cellular and sub-cellular level. Protoplasts of higher plants can be manipulated and mutagenised to obtain useful mutants that cannot otherwise be isolated. Viable protoplasts have been obtained in several genera of cultivated plants including tomato, tobacco, pulses,oilseeds and brinjal. Among these were several biochemical mutants.

GENETIC ENGINEERING

Characterisation of translation and transcription process in E.Coli.

Some characteristics of the trnslation process during amino-acid stravation in E. Coli have been examined and a model has been proposed for the course of events that possibly take place from the onset of starvation.

Cell differentiation and gene expression in plant tissues.

Studies on the incorporation of different aminoacids into the proteins of wheat embryo showed that incorporation was not uniform during the various stages of seed germination. These studies suggest that incorporation maxima of appropriate amino-acids can be used as markers of switching of specific protein synthesis during embryo development.

Biological nitrogen fixation

Work on nitrogen fixation in groundnut mutants indicate that high nitrogen fixation in TC-1 and TC-16 is mainly on account of higher photo-synthesis and translocation.

Mutants of Pisum sativum

Over 200 induced but independent mutants differing from the parent type in root and shoot characters have been isolated, many of which are hyper-nitrogen fixing mutants.

RESOURCES UTILIZED (MANPOWER):

Photosynthesis	: 11
Tissue Culture	: 6
Genetic Engineering	: 15

NAME OF THE INSTITUTION — SUGAR CANE BREEDING INSTITUTE COIMBATORE

AREAS OF WORK — TISSUE CULTURE

TISSUE CULTURE

A programme on improvement of sugar-cane through tissue culture technique has been taken up with the major emphasis on:

i) creation of genetic variability by chromosome manipulation through callus cultures for rectifying effects of varieties;

ii) Utilization of the techniques for interspecific and intergeneric genetransfer in sugarcane;

iii) production of sugar-cane virus free plants for germplasm maintenance.

Name of the Agency: INDIAN COUNCIL OF MEDICAL RESEARCH, NEW DELHI

Relevant Sector of Activity: HEALTH

A. COMMUNICABLE DISEASES :

(i) VIRUS DISEASES:

Research on arboviruses and other viruses are being carried out at the Council's National Institute of Virology at Pune and the ICMR Centre for Advanced Research on Virology at Vellore, Virus Research Units and time-bound projects initiated by the Task Forces in virology in different parts of the country.

The National Institute of Virology(NIV) is carrying out research on such important virus diseases such as Japanese Encephalitis (JE), Kyasanur Forest Diseases (KFD), Dengue, Phelebotomous Fever virus, influenza, measles, viral hepatitis and also interferon and vaccines against KFD and JE.

During 1981, NIV investigated several outbreaks of JE in Andhra Pradesh, Tamil Nadu, Pondicherry and Karnataka. The investigations comprised ecological, serological and vector aspects.

K.F.D. revealed as per the records of the Karnataka Government Public Health Services, the same epizootic and endemic activities and its usual severity.

During 1981, two outbreaks of influenza were investiated: (i) in February - March due to Influenza type B virus and (ii) in July - August due to Influenza A Virus. Zoonotic studies on influenza were also carried out. On viral hepatitis, studies carried out included hospitalised cases such as hepatitis, in pregnancy, prevalence of sub-type B surface antigen in the tribal population of Arunachal Pradesh, vertical transmission of hepatitis B virus, horizontal transmission of hepatitis B virus (HBV), application of ELISA techniques using penicillinase as marker for detection of HBSAg etc.

The National Institute of Virology, Pune, has now been designated as a National Centre for Influenza. A collaborative study on interferon between the CDRI, Lucknow and National Institute of Virology, Pune, under the financial assistance of D.S.T. is showing encouraging results.

The Enterovirus Research Centre, Bombay has now been designated as one of the permanent institutes of the Council. The Centre made a study of Poliomyelitis in Greater Bombay involving incidence, geographical distribution, seasonal distribution, age distribution, paralytic poliomyelitis, poliovaccine and virological studies for paralytic polimysitis, apart from studies on Coxsackie viruses in juvenile diabetes and cardiac pathology.

Apart from these two permanent institutes/centres, virological studies were carried out by the Centre for Advanced Research on Virology at the Christian Medical College, Vellore (on poliomyelitis, polio vaccine, hepatitis B virus, rotavirus and other enteroviruses) and at the ICMR Virus Unit at the School of Tropical Medicine, Calcutta (on dengue, JE and hepatitis B viruses) and in various projects initiated under the Virology Task Forces (on encephalopathy, viral hepatitis, rabies, enterovirus infection, tick-borne diseases, influenza and JE).

The Council has set up, in accordance with the recommendations of Task Forces on Influenza, 8 monitoring centres for Influenza at Calcutta, Bangalore, Ahmedabad, Calicut, Nagpur, Delhi, Chandigarh and Lucknow.

(ii) TUBERCULOSIS AND CHEST DISEASES:

Research on tuberculosis is being conducted mainly at the Tuberculosis Research Centre, Madras (TRC) and other projects initiated by Task Force on Tuberculosis in different parts of the country.

Tuberculosis Research Centre, Madras is continuing its efforts to evolve effective and practical short course chemotherapy regimens for the treatment of tuberculosis. The objectives of the Centre have been broadened to include the evaluation of inexpensive and effective chemotherapeutic regimens capable of mass application. Based on the exhaustive studies of TRC, domicillary chemotherapy has now been accepted as part of the Tuberculosis Control Programme. The main emphasis of the current che,otherapy trials being carried out at the TRC is to reduce the duration of the treatment of chemotherapy of tuberculosis. Several effective regimens have been determined. Those regimens include the use of drugs like rifampicin, streptomycin, isoniazid and pyrazinamide.

Other studies include the characteristics of Indian Tubercle bacilli, drug sensitivity tests, detection of drugs in urine, virulence in Indian guineapigs and isoniazid inactivation rate have greatly expanded the frontiers of knowledge in the field of tuberculosis. Studies on a typical mycobacteria and phage typing are activities recently introduced at TRC.

Other major studies include trial of efficacy of BCG vaccination in preventing tuberculosis in family contacts, treatment of tuberculosis of spine, chemotherapy of tuberculous meningitis in children, and studies of tuberculous lymphadenitis in children. TRC is also conducting extensive immunological studies on pulmonary tuberculosis and standardisations of ELISA for anti-PPD antibody.

A Study Group meeting on Tuberculosis held recently has led to 45 projects of covering epidemiological, clinical chemotherapeutic, microbiological and immunological aspects of Tuberculosis.

The Scientific Advisory Committee of TRC has recommended that the tuberculosis prevention trial be extended for 2½ years more. Studies on prophylactic value of BCG vaccination against leprosy have indicated a moderate protective effect of BCG vaccination against the development of serious as well as nonlepromatous forms of leprosy.

Studies are also ongoing on mycobacterial antigens, tropical eosinophilia, and other chronic pulmonary' diseases, as also on epidemiology of Klebsiella pneumoniae and pertussis.

Studies on "clinical, epidemiological and etiological aspects of acute respiratory diseases in infants and preschool children in urban-slum" are being conducted at V.P. Chest Institute, Delhi under the financial assistance of UNICEF.

(iii) LEPROSY:

Studies on leprosy are being conducted mainly at the Central Jalma Institute for Leprosy (CJIL), Agra, and other centres in different parts of India.

The CJIL has been engaged in studies on pathogenesis, immunology, chemoprophylaxis and chemotherapy of leprosy as well as rehabilitation of leprosy patients. Drug regimens with various combinations of drugs are being tested with an idea to prevent drug resistance. The drugs being used are DDS, rifampicin, chlofazimine and thiacetazone. Immunological aspects being studied include antigenic profile of lepromin, comparison on lepromin and leprocin A, antibodies to M. leprae, etc. CJIL has augmented its research on the biochemical, microbiological, pathological and serological aspects of leprosy and field studies, as also on the psycho-social aspects of leprosy.

The recent Study Group Meeting on Leprosy has initiated 43 projects on different aspects of leprosy research such as epidemiology, clinical manifestations, chemotherapy, laboratory study, immunology and vaccine development.

(iv) CHOLERA & ENTERIC DISEASES:

The National Institute of Cholera and Enteric Diseases, Calcutta (NICED) continues its studies on diarrhoeal diseases including training of medical and para-medical personnel in the management of these diseases. The Institute has been engaged in efforts to popularise a simple and inexpensive form of oral rehydration therapy in the treatment of diarrhoeas at the community level. Interesting data have been obtained on transmission of V. parachaemolyticus in Calcutta slums. Studies on intervention of transmission of V. Cholerae in Calcutta communities are being continued. Ecological studies of hospitalised cases with acute diarrhoeal diseases have revealed higher rate of detection of rotavirus amongst children below 2 years of age (22.2%). Rotavirus could also be detected from different age groups including adults. Studies on immunological response in sera and the secretions of acute convalescent cholera patients, have yielded interesting results. NICED conducted 20 National Seminars on Oral Rehydration Therapy (ORT) in collaboration with the DGHS and WHO. The Institute is rendering referral services as WHO Collaborating Centre for Reference and Research on vibrios.

Studies are being conducted in the field of amoebiasis with emphasis on immunological aspect of amoebiasis. Studies are also being conducted on intestinal helminths. Studies on diarrhoeal diseases are also being conducted under the fellowship programmes of the Council.

The Council has strengthened the National Shigella Centre, K.G. Medical College, Lucknow, and Salmonella Centre at Central Research Institute, Kasauli.

The Council has initiated an extensive programme on research in diarrhoeal diseases under the financial assistance of UNICEF in different Institutes in India. These studies include the effect of oral fluid therapy in neonates and infants, at the peripheral levels, microbial etiology of acute diarrhoeal diseases, transmission of enteropathogens etc. The results are encouraging.

(v) VECTOR BIOLOGY & CONTROL:

The Vector Control Research Centre, Pondicherry (VCRC) continued its studies on general entomology, ecology and behaviour of selected vector species in problem areas with reference to the control of vectors and role of primary and secondary vectors, genetical and biochemical basis of insecticides resistance, toxicological evaluation of insecticides and development of technology for control of vectors in different situations. Studies are also being carried out on biological control including colonisation and mass rearing of biological vectoricides. VCRC has initiated 2 major

projects viz. "Feasibility studies on the environmental control of vector in villages" and "Demonstration of control of bancroftian filariasis" in Pondicherry by controlling the vectors, which have yielded encouraging results.

VCRC is also conducting research on various aspects of malaria and as malaria vector studies in Rameswaram Island; incrimination of Anopheles subpictus as a malaria vector; and on malaria in coastal villages. These studies have given encouraging results.

(vi) FILARIASIS:

The Study Group Meeting on Filariasis has initiated 24 studies on epidemiological, chemotherapeutic and immunological aspects of filariasis. Field studies comprise those on feasibility of environmental control of vectors, epidemiological and immunological aspects of W.Bancroftia infection in Orissa, demonstration of control of Bancroftian filariasis, immunology of bancroftian filariasis, serodiagnosis of filariasis, cytogenic and immunological studies on bacroftian filariasis in India.

(vii) MALARIA:

The Council is giving high priority to research in malaria. The studies on various aspects of malaria are being conducted at the Malaria Research Centre, Delhi(MRC) as well as at VCRC, Pondicherry and in a few other centres all over the country.

Malaria Research Centre, Delhi:

The activities of the Malaria Research Centre, Delhi, consisted of field research on the vector colonisation, vector ecology, vector genetics, mode of inheritance of insecticide resistance, species complex, sibling species, cytogenetics of Anopheles stephensi, in vitro cultivation of Plasmodium falciparum and collaborative field research studies.

Projects (15 in number) on different aspects of malaria are being conducted in different institutions all over India under the sponsorhip of a High-Powered Board of Malaria and the Council.

These involve studies on operational aspects of malaria control, ecology and control of vector of malaria, chemotherapy of malaria, serology of malaria and in vitro cultivation of malaria and immunological aspects of malaria.

For the first time in India in vitro continuous culture of P. malaria and P. falciparum was established by an ICMR study at the National Institute of Communicable Diseases, Delhi.

The Study Group meeting held on January 11-13, 1982 on serology, immunology and in vitro cultivation of malaria recommended that collaborative study should be initiated in 6 Centres. Emphasis on production of malaria vaccine was laid down on projects on immunological aspect of malaria. Study Group Meeting on chemotherapy, drug resistance vectors control held on January 19-21, 1982 noted the progress of work on these projects which were found to be satisfactory.

(viii) KALA-AZAR:

The Rajendra Memorial Research Institute of Medical Sciences, Patna which has been recently taken over by the ICMR has concentrated its efforts on Kala-azar research. Several other projects on Kala-azar have been initiated as per recommendations of the Task Force on Kala-azar. These studies include such aspects as phlebotomine sandflies in relation to Kala-azar in India, chemotherapy, epidemiology, immunology (including immunoprophylaxis and immunology of post-kala-azar dermal leishmaniasis) and ecology of Phelebotomous argentipies in West Bengal.

(ix) MICROBIOLOGY (INCLUDING BACTERIAL INFECTION)

The Streptococcal Diseases Reference Laboratory at the Lady Hardinge Medical College, New Delhi, has concentrated its activities on bacteriological and serological aspects of streptococcal diseases and also on imparting training in this area.

The National Pseudomonas aeruginosa Centre at the All India Institute of Medical Sciences, New Delhi, continued its service research and training activities in the field of Pseudomonas acruginosa. The work on aeruginocin typing of strains is encouraging. The staphylococcus Phage Typing Centre, at the Maulana Azad Medical College, Delhi continued production of staphylococcal typing phages in bulk phage typing of Staphyloccus aureus received from other institutions in India. The Centre has trained workers from other parts of India.

(x) The Council has initiated several projects on sexually transmitted diseases.

(xi) HEALTH CARE DELIVERY:

The Council is giving emphasis to research on health care delivery. The Task Force on health care delivery recommended development of newer model for health care delivery, evaluation studies, orientation studies, intervention studies and comprehensive studies. Several projects have been initiated on the basis of recommendations of Task Force on Health Care Delivery System; on the evaluation of

community health volunteer scheme, study of health manpower in selected specialities and super-specialities, delivery of health care for rural children, study of principles and patterns of health care delivery systems, and developing an urban model for delivery of health care services.

The Council has initiated extensive programme on research in health care delivery under financial assistance of UNICEF. These studies include evaluation of existing pattern of health care delivery system, evaluation of C.H.W at peripheral level and system analysis approach of primary health care.

The Council has constituted a Consultative Group on Health Services Research, on the recommendations of which preparatory phase studies for the study of comprehensive health care at district levels in 6 centres in India have been initiated. These studies propose to investigate composition of the population; Community health resources; Community service interface; inter-sectoral development; Health Services; and Health Information System.

The Group has emphasised that the health services research would be meaningful only with close collaboration with the state and district health authorities.

(xii) Regional Medical Research Centres - Two Regional Medical Research Centres have been set up by the Council -

a) Regional Medical Research Centre, Bhubaneshwar.

The aims and objectives of the Centre are:

1) To promote biomedical research in communicable diseases (filariasis, malaria and leprosy) and nutritional problem and human reproduction.

2) To interact with local health authorities to help in finding out solutions to their health problems in the region.

3) To help in giving better medical health care to the tribal population of Orissa.

4) To help in attracting young talented medical graduates of Orissa to take up research as a career.

b) Regional Medical Research Centre, Shillong:

The aims and objectives of the Centre are:

1) To promote biomedical research in priority areas of relevance to the regional population, such as Communicable diseases, Human reproduction and nutrition.

2) To train technical manpower in North Eastern Region in the above areas.

3) To interact with local health authorities to help in finding out solutions to their health problems in the region.

4) To collect information for effective traditional system of medicines among local tribal population and to provide suitable guidance to them.

(xiii) MEDICAL STATISTICS:

a) Institute for Research in Medical Statistics, New Delhi is continuing its services in health information system, analysis and evaluation or research projects under ICMR, hospital statistics, data bank and training in statistics.

b) Institute for Research in Medical Statistics, Madras is continuing its activity morbidity and mortality statistics, analysis of leprosy control programme and health service research.

C. BASIC MEDICAL SCIENCES

(a) Activities at Institute of Pathology

During the year three collaborating centres, at JIPMER, Pondicherry, Assam Medical College, Dibrugarh and at J.N. Medical College, Belgam have been started. There would be greater collection and inflow of material by these new Centres. At JIPMER it is planned to organise a workshop on Ocular Pathology.

(b) Medical Education Technology: Preparation of low cost teaching aids and visual aids with the help of indigenous technology has been one of the primary activities of the Institute of Pathology.

For the Continuing Medical Education Programme of the Neurological society of India, 250 sets of 10 CAT-scans were prepared. This entire work was completed in 24 hours with the help of Nikon Optical Printer. 100 slides were photomicrographed for the set on Tumours of Salivary glands. Out of these 70 slides have been selected for duplication.

(c) Research Activities: In the field of Immunopathology, three established cell lines, HEP-2, Vero and BHK-21 were received from NIV, Pune, and the cell lines are maintained. It has been planned to investigate the

presence of antibodies against cytoskeleton filaments in cases of rheumatoid arthritis and other autoimmune and non-auto immune diseases in Indian population.

Another study to assess the immune status of the newborns and its correlation with the nutritional and immune status of the mother has been undertaken. Sera from about 100 newborn infants at varying intervals have been collected for determination of humoral immunity. Stools on the corresponding days are collected to find out any extra loss of immunoglobulines. Similarly, breast milk of the mother is collected to assess the immune status.

A correlative study on needle aspiration cytology and histopathology of breast lesions has been undertaken. A total of 204 cases of breast lumps have been included in the study. On needle aspiration and staining with appropriate stains, and later biopsy, a large percentage (63.2%) were found to be benign lesions. Highest correlation was observed in cases of fibroadenomas. Sixty five cases were diagnosed as cytologically malignant and 41 were confirmed histopathologically.

The first phase of the project on leprous phlebitis was brought to a satisfactory conclusion.- A total of forty cases of lepromatous leprosy with venous involvement have been studied.

(d) Blood Group Reference Centre continued to provide reference service for immunohematological investigations as well as carried out research activities on a number of projects. i.e. on red cell antigens, HLA antigen, immunoglobulin, hepatitis B surface antigen, red cell enzymes, complement studies, abnormal haemoglobins and immunofluorescence studies in idiopathic thrombocytopenic purpura and other autoimmune disorders.

The Centre organised a WHO/ICMR Group Educational Activity Meeting on Immunological Concepts in Hematology.

The Indo-German Symposium on Different Aspects of Immunohematological Problems was held in Munich from May 25-29, 1981 and was attended by 9 Indian delegates. The deliberations have given impetus to the development of newer areas in immunohematology with Indo-German Collaboration.

(e) ICMR Haematology Unit, Calcutta is studying the relationship between anaemia and immunocompetence in children as well as adults. and anaemia in kala-azar,

epidemiology of morbidity in thalassaemia patients, and on leukemia bone marrow cytology, plasma 59 Fe clearance 1/2 time and incorporation of 59 Fe in red cells in Kala-azar cases suggest ineffective erythropoiesis in Kala-azar in Kala-azar which together with other abnormalities contributes to anaemia in this diseases.

In immune competence study T lymphocytes evaluated by uptake of 3H thymidine was depressed in all patients of anaemia. Low values were also obtained for leucocyte migration inhibition factor (MIF) activity. Following oral iron therapy for 12 weeks improvement in the number of T lymphocytes was found in majority of the patients and the function of T lymphocytes became normal in all patients. In folate deficiency anaemia the mean number of T cells was lower in patients as compared to controls and the 3H thymidine uptake was markedly depressed. Low values were also obtained for leucocyte MIF. Following specific therapy, the number as well as function of T cells improved but the change was not as marked as in IDA. Marginal improvement was noticed in MIF activity also.

B lymphocytes and their function (as evaluated by the level of immunoglobulins IgG, IgA and IgM) was similar in IDA patients, folate deficiency anaemia and normal controls.

Preliminary data obtained in leukemia studies show that in all patients T lymphocytes including early acting lymphocytes were decreased, the exception being T cell leukaemia. Following therapy and remission, the proportions of T and B cells improved, whereas the number of Null cells remained higher than normal.

(f) Advanced Centre on Research in genetics and Cell Biology at the Indian Institute of Science, Bangalore, a large number of clones of human placental DNA have been prepared by 'Shot Gun' approach in PBR. They are now being screened to identify those clones which carry X chromosome specific DNA. The cloning experiments are undertaken for the development of recombinant technology for investigating human chromosome inactivation and producing some useful proteins.

The Centre for Advanced Research in Neuro-Psychopharmacology at K.G. Medical College, Lucknow continued studies on the central control of cardiovascular functions. Recently in depth studies have been initiated on the mature and function of adrengergic and cholinergic regulation.

It is proposed to establish three advanced research centres on Neurobiochemistry, Haematology and Neurophysiology at Hyderabad, Chandigarh and Panaji (Goa) respectively.

(g) Talent Search Schemes:

The Talent Search Scheme (TSS) fellowship programme was initiated in 1975 with the object to "pick up" young talented medical graduates immediately after graduation and deliberately groom them for a career in medical research.

During the years 1975-81, 66 candidates have joined the T.S.S. fellowship.

(h) Short Term Research Studentship

The Council initiated short term research studentship programme in 1979, in order to promote interest for research among medical undergraduates. The main objective of this programme is to provide an opportunity to undergraduate medical students to familiarise themselves with research methodology and techniques. This may serve as an incentive for them to take research as a career in future.

During the last three years (1979-1981), 300 candidates have joined this studentship programme. This programme has become highly popular in the medical colleges of the country.

(i) Indo-Foreign Collaboration

The Council coordinates biomedical research agreements between India and other countries. As many as 20 agreements with different countries have been signed during the past few years. During the last couple of years, activities under agreements with the Federal Republic of Germany, United Kingdom, United States of America and Union of Soviet Socialist Republics have been initiated and are progressing satisfactorily.

(j) Awards and Prizes

In order to provide incentives and recognition for medical research of a high order, the Council awarded 13 awards and prizes to 18 eminent Scientists for 1981.

D Reproduction Biology and Nutrition

(i) CONTRACEPTION RESEARCH:

A variety of efforts are being made which include basic as well as clinical research. A specific factor called Inhibin has been studied which is said to be a specific gonadal factor to supress FSH activity. It is likely that further work done on this substance may provide useful leads for male fertility regulation. Basic research on the immunological aspects of contraception including development vaccine for male and female fertility regulation is also being undertaken. Effort has been made to plan time-bound studies on agents interfering with follicular maturation and implantation. As regards the clinical trials of new contraceptives studies of intra-nasal spray of contraceptive drugs and chemical occlusive agents have been initiated. Phase III clinical trials on injectable Norethisterone enanthate as well as Filshie Clip for tubal occlusion are on-going. Preliminary data on 1500 women indicate that the two-monthly 200 regimening of NET enanthate does give rise to pregnancy in some subjects but the incidence is much below the termination criteria for the clinical trial. Similarly, the Filshie clips for the clinical occlusion of tube may be useful only with trained personnel. In another multicentric clinical trial, the quick-acting Isaptent developed by CDRI, Lucknow, (which is said to give adequate dilation in 4-6 hrs.) was studied in the ICMR network of Human Reproduction Research Centres and compared with the commonly used Laminaria tent as well as manual dilation procedure for its efficacy to dilate the cervix to 8-10 mm in 4-6 hrs. as well as for any local complications. The preliminary data indicate that in more than 70 per cent of subjects, Isaptent could give 8-10 mm of cervical dilation. This data suggests that the quick-acting Isaptent can be used for cervical dilation in women requesting medical termination of pregnancy during the first trimester. The Council is also making efforts to study the psycho-social and cultural factors which influence the continuation and discontinuation rates of IUDs and oral contraceptive pills in rural and urban centres. Health care delivery services related to family planning, are also being studied. Anti-fertility plant products are also being studied. Most of these compounds are still at an early stage of investigation of their possible biological efficacy in suitable animal models as well as for their toxicity.

(ii) MATERNAL & CHILD HEALTH

The recent census report indicates that the maternal, perinatal and infant mortality rates continue to remain high in most states of our country. The available evidence suggests that major neonatal morbidities and mortalities occur due to continuation of maternal risk factors from the intrauterine to neonatal period. As advised by the Advisory Group of the ICMR on Maternal & Child Health, several studies have been initiated to identify high risk pregnancies not only at the hospital/medical institutional level but more importantly at the rural/urban slum centre by health workers used in the current health care delivery system in the country. These ongoing studies are trying to find out the identifiable high risk factors so that they could be recognized early and then appropriate intervention studies will be taken to find out whether they can prevent the adverse outcome of pregnancy. In addition, a study to identify genetic causes of mental retardation for their prevention and management have been undertaken on a multicentre basis. The nodal point of this activity is a proposed medical genetic research centre in Bombay, the nucleus of which is at present located at the Council's Institute for Research in Reproduction, at Bombay. Negotiations are underway between the Bai Jerbai Wadia Hospital for Children and the ICMR to construct such a centre in the premises of the Children hospital. After approval by the Scientific Advisory Board, this proposal would be processed further. There is also a proposal to set up a High Risk Pregnancy research wing of the ICMR at Nowrosjee Wadia Maternity Hospital.

Studies are planned to be undertaken on breast feeding practices in India during the next financial year. For the delivery of MCH care, several alternative strategies have been proposed such as regionalization of perinatal care, establishment of delivery centres at the community level and strengthening of MCH care by comprehensive domiciallary approach. It is proposed to develop low cost intervention technology which would hopefully be utilized in the health services infrastructure and the facilities provided by the State for the delivery of MCH care.

(III) NUTRITION

Interim analysis of a community based study undertaken by National Institute of Nutrition at Hyderabad on prophylaxis by massive dose of vitamin A has shown that there is a gradual decline in the inflow of cases of corneal involvement and kerotomala-

cia due to vitamin A deficiency with this programme. A centre to undertake comprehensive study on the prevention of nutritional blindness has been established in at Sarojini Eye Hospital and the NIN, Hyderabad under the aegies of Indo-US collaboration. A study has been initiated on the health and nutritional status of tribal population.

Among various national nutrition programmes, supplementary feeding programmes for the vulnerable segment of population such as world food programme (WFP) in terms of soya fortified bulgar wheat (SFW) and butter oil. This programme is now being evaluated at the request of the Ministry of Social Welfare Government of India, with the active involvement of the staff of the regional units of National Nutrition Monitoring Bureau. This evaluation will continue for the next year. A project for investigation into the factors that determine Health Status of Community funded by Ford Foundation has been on-going in the three selected States viz. Uttar Pradesh, Tamil Nadu and Kerala. The baseline data on the demographic parameters from these States has already been collected and analyzed during this year. These results confirm the original criteria laid down in the selection of areas for the project being 30,45 and 60 units which is based on the infant mortality rates. The denographic repeat surveys nutritional assessments, diet, socio-economic status, KAP, environmental sanitation and morbidity surveys are in progress. Investigation of factors that determine the health status of a community as well as the effect of mild and moderate protein energy malnutrition on the growth, development, morbidity factor, intestinal absorption and immuno competence in children are in progress. It is proposed next year to initiate another multicentre study which will look into the nutritional problems of anaemia during pregnancy and design suitable intervention strategy.

The role of National Nutrition Monitoring Bureau (NNMB) is being reviewed by a consultative Group in order to redesign its objectives to meet the changing needs and also for analysis and interpretation of the data already collected by the NNMB and further integrate their functioning with the existing state infrastructure. After completion of this review, a decision will be taken on the new objectives of the NNMB as well as on the need to increase the number of such Bureau from the existing 10 to 18 so as to cover other states.

Name of the Agency: UNIVERSITY GRANTS COMMISSION

KARNATAKA UNIVERSITY

SECTOR: ENVIRONMENT

Research is being carried out in the following areas:

1. Sewage stabilisation in ponds;

2. Toxicity of industrial effluents and their toxic chemicals;

3. Disposal problems of effluents from poly-fibre factory and on the floride content in natural water of Dhanbad District.

CALICUT UNIVERSITY

SECTOR: HEALTH

Areas of activity: Tissue Culture

Manpower 5 scientists involved in research and teaching.

Research is being carried out in the following areas:

1. Effect of UV on macromolecular synthesis (DNA, RNA and proteins) with reference to mitosis in Physarum is being studied. Cultured plasmodia of Physarum are irradiated with UV light to study its effect on DNA, RNA and protein types inhibited at synthetic level or destroyed at post-synthetic level. Cloning of the gene(s) and immunological studies are being planned for future

2. Effect of caffeine on mitotic rhythms and DNA repair process after UV irradiation in Physarum and mammalian lymphocytes are being carried out as part of a programme of studies on environmental mutagenic and carcinogenic agents on cells.

GUJRAT UNIVERSITY (DEPTT. OF MICROBIOLOGY)

Research is being carried out in the following areas:

1. Microbial deterioration of materials such as pharmaceuticals;

2. Bacterial diseases of cereals;

3. Pesticide microbiology;

4. Development of bacterial fertiliser and their impact on agricultural farming;

5. Microbial degradation of lignins and lignocellulose;

6. Extraction of oleoresins;

7. Waste utilisation - Effluent treatment;

8. Wax from sugarcane pressmud.

KALYANI UNIVERSITY

SECTOR	AGRICULTURE
Areas of Work:	Genetic Engineering, Tissue Culture
Manpower:	6 scientists

Research work is being carried out in the following areas:

1. Photosynthetic efficiency of aquatic and shade-loving plants has been studied. Photosynthesis and photo-respiration of the leaves and spikelets have been investigated.

2. Nif gene has been detected in cucurbits and few fungi. Efforts are being made to transfer the plasmid DNA from micro-organisms where nif gene resides on the plasmids to root hairs and cells of maize rice etc.

JADAVPUR UNIVERSITY, CALCUTTA

SECTOR	HEALTH, AGRICULTURE, INDUSTRY
Areas of Work:	Enzyme Engineering, Alcohol Fermentation

Research work is being carried out in the following areas:

1. Production of single cell protein (yeasts) from food and agricultural wastes;

2. Production of mushrooms (Agaricus, Morchella, Volvariella) by submerged culture fermentation;

3. Studies on toxin-producing moulds and mycotoxin production in food and agricultural commodities and their control;

4. Fermentative production of Alcohol from indigenous starchy raw materials including wastes;

5. Development of fermentation processes for production of antibiotics like neomycin, kanamycin and a new antifungal antibiotic;

6. Microbial production of amino acids (glutamic acid, threonine, valine);

7. Production of microbial enzymes like α-amylase, amyloglucosidase, pectinases, lipase, lactase, glucose isomerase;

8. Use of immobilised enzyme systems or whole cells for
(a) conversion of starch to high fructose syrup
(b) hydrolysis of lactose in milk or whey to easily digestible sugars;

9. Preparation of immobilised enzymes or whole microbial cells containing the enzymes (lactase, lipase, amylases, glucose isomerase) and their application to food processes;

10. Microbial production of alcohol from different starchy materials (shatti, tapioca, potatoes);

11. Microbial production of α-amylase and amyloglucosidase;

12. Microbial cells having the enzyme (lactase, lipase) activities have been selected, different kinetics parameters studied and followed the immobilisation techniques with agar-agar and gelatin. Immobilised enzyme ractors have been developed in our laboratory and mathematical models are used to determine the optimal reactor operating conditions.

Isomerisation of glucose to fructose by the enzyme, glucose isomerase from Streptomyces fradiae and Streptomyces kanamyceticus is in progress.

13. Studies have been made for production of alcohol from starchy raw materials involving enzymatic saccharification of starch followed by alcohol fermentation. These have led to the isolation and development of a mutant strain of Aspergillus oryzae

producing high levels of amylase and amyloglucosidase. By the use of this culture, it has been possible to get about 90-95% conversion of starch in potato, shatti and tapicoa to glucose.

BHARATHIAR UNIVERSITY, COIMBATORE

SECTOR	ENVIRONMENT
Areas of Work:	Photosynthesis and Tissue Culture
Manpower:	one scientist in photosynthesis and two scientists in Tissue culture.

Research is being carried out in the following areas:

1. Survey on mangrove forests;
2. Embryology and anatomy of mangroves;
3. Confirmation of taxonomic species;
4. Afforestation - artificial regeneration - introduction of new species including exotic species.

NAGPUR UNIVERSITY

SECTOR	AGRICULTURE, ENERGY and INDUSTRY

The following projects are in progress:

1. Saccharification of agricultural wastes was carried out by Trichoderma viridae, Aspergillus niger using solid culture technique to produce reducing sugar.
2. Isolation and immobilization of industrially important enzymes.
3. Alcohol production from glucose sugar and saccharified agricultural wastes, using Saccharomyces cerevisae
4. Biogas production from agricultural wastes.

ANNA UNIVERSITY, GUINDY, MADRAS

SECTOR	AGRICULTURE, INDUSTRY and HEALTH
Area of Work:	Fermentation technology

Manpower: 10 scientists

Following projects are being undertaken:

1. Fractionation of fats and oils
2. Refining of fats and oil
3. Starch from oil cakes
4. Nutritional and biochemical studies of vegetable fats
5. Production of nicotinic acid and niacin

OSMANIA UNIVERSITY, HYDERABAD

SECTOR: AGRICULTURE

Areas of Work: Genetic Engineering, Photosynthesis, Tissue Culture, Enzyme Engineering, Immunology

Manpower: 71 scientists

Research work is being carried out in the following areas:

1. Mutational studies in rice: Mutational studies at the whole level to improve rice, led to the isolation of short culmed mutants like dwarfs, semidwarfs and extreme dwarfs from IR-8 and several other local cultivar.
2. Gene action and gene regulation of anthocyanin in maize: In maize, through inter-tissue complementation technique anthocyanin pigment complementarity and other genes have been analysed into indirectional sequence.
3. Biochemical aspects of disease resistance: Studies regarding the total turnover of proteins/peptides of enzymatic/non enzymatic nature, free amino acids and other metabolic products like phenols, reducing sugar at various stages of growth in resistant and susceptible varieties of rice are being made.
4. Efforts are being made to evaluate the photosynthetic characteristics of different induced dwarf rice varieties in relation to their productive capacity.
5. Economically important plants such as rice, triticale, maize, soyabean, groundnut, pigeon pea, castor, safflower, papaya, grapes are being cultured for their regenerative ability.

6. Studies on genetic properties of nitrogen fixing bacteria and hydrocarbon degrading microbes: Efforts are being made to develop 'plasmid technology . The technique of 'protoplast fusion' in the area of hydrocarbon degradation is being developed.

7. Studies on alcohol fermentation from natural carbohydrate material are being carried out. Efforts are being made to use cellulose for the production of glucose and ultimately for alcohol using various molds.

M.S. UNIVERSITY OF BARODA, BARODA

SECTOR	AGRICULTURE, ENERGY, ENVIRONMENT and INDUSTRY
Areas of Work:	Genetic Engineering, Alcohol Fermentation
Manpower:	10 scientists

Research work is being carried out in the following areas:

1. Nitrogen fixation: Considerable work has been undertaken on the symbiotic nitrogen fixation by Rhizobia. Different methods of gene transfer as well as other technique are being used to study the regulation and organisation of nitrogen fixation gene. Aspects like protection oxygen sensitive enzyme nitrogenase generation of energy and reduction potential for the reduction of molecular N_2 and the enzymes involved in NH_3 assimilation are emphasised including regulatory features involved.

2. Biotransformation of plant latex for fuels and chemicals: Work on biotransformation of plant latex of Calotropis and Euphorbia using Aspergillus sp. is under way.

3. Microbial degradation of aromatic & aliphatic hydrocarbons: Studies on microbial degradation of aliphatic and aromatic hydrocarbons of petroleum waste were carried out so as to remove its toxicity in general and particularly its phototoxicity enabling its possible use as even fertiliser.

4. Studies on sewage sludge hygenisation by gamma radiation: Studies like analysis of microbial flora of sludge from municipal sewage treatment plants standardisation of doses of γ-radiation using cobalt-60 and other factors affecting this process are in the progress

Studies on fermentative production of vitamin Riboflavin and B-carotene: Fermentative production of riboflavin by using yeast Erymothecium ashbhyii was carried out. Detailed studies on the factors controlling biosynthesis and on regulation of B-carotene were undertaken inmold B. trispora.

MADURAI KAMARAJ UNIVERSITY, MADURAI

Research is being carried out in the following areas:

1. Cloning of Biocide gene from Bacillus sphaericus, B. thuringiensis
2. Molecular mechanism of restriction enzymes and structural and functional organisation of genes controlling these activities.

INDIAN INSTITUTE OF SCIENCE, BANGALORE

Research is being carried out in the following areas:

1. Specific gene expression in rinderpest virus.
2. Histone gene organisation in rice embryos.
3. Structure and expression of genes regulating silk fibroin synthesis in Bombyx mori.
4. Molecular basis of drug metabolism in animals.
5. Regulation of nitrogen fixation in nitrogen fixing bacteria.
6. Regulation of liquid metabolism in plants.
7. Biological functions of H_2O_2.

BANARAS HINDU UNIVERSITY, VARANASI

Following research work is being done:

1. Molecular biology of a new bacterial virus (MB 78)
2. Nitrogen fixation in blue green algae
3. Molecular basis of host virus relationship
4. Virus induced changes in Salmonella typhimurium
5. Biochemistry and genetics of bacteriophage P_{22}
6. Regulation and expression of bacteriophage P_{22} genes
7. Cloning of RNAase I gene of E. coli.

JAWAHARLAL NEHRU UNIVERSITY

Studies are being carried out in the following areas:

1. Expression of nitrogenase gene in non-symbiotic plant system.
2. Search for genes involved in the protection of nitrogenase against oxygen.
3. Optimization of expression of nitrogenase structural gene in E.coli and yeast.
4. Development of vectors for gene transfer suitable for plant systems.
5. Transfer of 'nif' genes into plant cell so as to study their expression.

BOSE INSTITUTE

Research is being carried out in the following areas:

1. Structural organisation of 'nif' genes of S. lipoferum
2. Development of lambda vector for cloning genes.
3. Cloning of fungal diastase gene in E. coli.
4. Organisation and expression of RNA and protaniene genes in cat fish.

MAJOR BIOTECHNOLOGY PROGRAMMES FUNDED BY D.S.T. FROM 1975 ONWARDS

TISSUE CULTURE

S.No.	Project	PI & Institution
1.	Establishment of nitrogen fixing bacteria as permanent endosymbionts of leguminous plants developing from callus culture.	Dr. D.N. De, IIT, Kharagpur.
2.	Rapid clonal propagation of some important tree crops of India for crop improvement by tissue culture techniques and mutation breeding.	Dr. V.J. Philip Calicut University, Calicut.
3.	Application of tissue culture for industrial production of some important plant constituents.	Prof.A.N. Saoji, Nagpur University, Nagpur.
4.	Studies on tissue culture and somatic hybridization in some crop plants.	Dr.H.Y. Mohan Ram, Delhi University, Delhi.
5.	Application of plant tissue culture methods for improvement of economically important plants with special reference to molecular aspects of differentiation.	Prof. T. Ramkrishnan I.I.Sc, Bangalore.
6.	Regulation of Proliferation of normal and neoplastic cells in culture.	Dr. G.Shanmugam, MKU, Madurai.
7.	Rapid multiplication and improvement of Economically important plant of Rajasthan through tissue growth, differentiation and Establishment in culture.	Dr.H.C.Arya, Jodhpur Univ., and Dr.O.P.Pareek, CAZRI, Jodhpur.
8.	Application of Plant tissue culture for clonal propagation and production of secondary metabolites in medicinal plants.	Prof.CS Vaidyanathan and Prof.T.Rama-Krishnan, IISc., Bangalore.
9.	Utilisation of haploids to evolve physiological and biochemical mutants for their future use in crop breeding.	Dr. SK Sen, Bose Institute, Calcutta.

10.	Biosynthesis of primary and Secondary products from Medicinal Plant tissue cultures in vitro or fundamental studies of plant tissue culture as a means of making useful products from agricultural raw materials.	Dr.(Mrs) Pushpa Khanna, Univ., of Rajasthan.
11.	To establish a tissue culture laboratory primarily to multiply virus free sugarcane for use as seed cane using technology developed by NCL, Pune.	Dr.AK Deshmukh Nimbkar Agricultural Res. Instt. Phaltan.
12.	Clonal propagation and Improvement of Steroidal sapogenin yielding Commiphora mutant by tissue culture methods.	Dr.A.R. Mehta, Prof. of Botany, MS University, Baroda.

ENZYME ENGINEERING

1.	Solid enzyme reactor for fertiliser waste treatment.	Prof.AVS Prabakra Rao, IIT, Kanpur.
2.	Studies on affinity system and their applications in Enzyme Engineering.	Prof. PK Bhattacharya,IISc, Bangalore.
3.	Enzyme engineering and its applications in medicine.	Prof. BK Bachhawat IICB, Calcutta.
4.	Enzyme engineering programme at Hindustan Antibiotics research centre.	Hindustan Antibiotics, Pimpri.
5.	Preparation of immobilised enzymes or whole microbial cells and their application in food processes.	Prof. SK Majumdar Jadavpur Univ., Calcutta.
6.	Application of enzyme engineering in medical usage.	Dr.DK Basu SCTMC,Trivandrum.
7.	Basic Studies in Enzyme engineering.	Prof.PK Bhattacharya IISc. Bangalore.

PHOTOSYNTHESIS

	PROJECT	PT & Instt.
1.	Study of enzymes of C_4 pathway in C_3 plants.	Prof.A.Gnanam. MK University, Madurai.
2.	Interspecific and intergeneric hybridization leading to the transfer of C_4 phenomena in C_3 plants.	Prof.VS Ramdas, Sri Venkateswara University, Tirupati.
3.	Photosynthesis in plants of saline environment, studies in Suada martime.	Dr.S.M.Karmarkar Ramniranjan Jhunghunwala College, Bombay.
4.	Photosynthesis and marine environment	Dr.CV Joshi Shivaji University, Kolhapur.
5.	Photosynthetic characterization of Indian desert grasses and legumes.	Dr.N. Sankhala Jodhpur University, Jodhpur.
6.	Energetics and the ultra structure of the developing photosynthesis apparatus during greening of etiolated leaves.	Dr.GS Singhal JNU, New Delhi.
7.	Studies on delayed light emission from photosynthetic membranes.	Dr.V.C.Tatake, BARC, Bombay.
8.	Study of the effect of Pyridazinone compounds on photosynthetic activities of crop plants with the aim of improving tolerance to high environmental temperatures.	Dr.Salil Bose, MKU, Madurai.
9.	Pre-workshop training pregramme for young scientists in connection with workshop on physiological investigations in tree crops.	Dr. MR Sethuraj, Rubber Research Instt., Kottayam.
10.	Photosynthesis in relation to nitrogen assimilation	Dr. S.K. Sinha IARI, New Delhi.
11.	Regulation of photosynthetic carboxylases towards plants productivity.	Dr. K. Francis, Madras University, Madras.

IMMUNOLOGY

1.	The in-vivo development of vaccine against viral hepatitis type B using new born Oractologus curiculus model system.	Dr.MVN Shirodkar Haffkine Institute Bombay.
2.	Immunoprophylaxis and immunotherapy against Pseudomonas aeruginose infection.	Prof.Shrinivas AIIMS, New Delhi.
3.	Monoclonal antibodies to Simian and human malaria antigens by lymphocyte hydridoma.	Dr.(Miss)Q.Z.Hussain Biochemistry Divn., NICD, Delhi.
4.	Immunogenicity of Glycolipids of Mycobacterium tuberculosis.	Dr. D. Subramanyam Ceba Geigy Research Centre, Bombay.
5.	An immunological approach to Genetics	Prof.TM Jacob, IISc. Bangalore.
6.	Biochemical, Pharmacological and Immunological studies of the Venoms of snakes in India.	Dr.BB Gaitonde Haffkine Institute Bombay.
7.	Multidisciplinary research in Genetics including Genetics of Drosophila and mice, population genetics, immunogenetics and enzymology.	Prof.O.S.Reddy Instt. of Genetics Hyderabad.
8.	Development of a safe and Effective vaccine against Rabies, prepared in Tissue Culture.	Dr.HJ Manshramani AIIMS, New Delhi.
9.	Immunodiagnostic and other studies in Bancroftial Filariasis.	Prof.B.C.Harinath. M.G.I. of Medical Sciences,Wardha.
10.	Immunovirology of squamous cell carcinoma of uterine cervix.	Dr. Pradeep Seth AIIMS,New Delhi.
11.	Immunity in Amoebiasis study of host-parasite interaction at the Macromolecular level.	Dr.Sehail Ahmed, A.M.U,Aligarh.
12.	Significance of circulating immune complexes (antigen-antibody complex) in health and disease.	Dr.AN Malviya AIIMS, New Delhi .
13.	Immunodiagnostic tests for the detection of Asymptomatic Malignant Neoplasms.	Dr.D.Udayachander Madras University, Madras.

14.	Disorders of sexual development immunogenetic studies with special reference to HY antigen and evolution of methods for their management in India.	Dr.I.C.Verma AIIMS, New Delhi.
15.	Cell-mediated Immune Response of Childhood Tuberculosis	Dr.(Mrs)Vimlesh Seth. AIIMS,New Delhi.
16.	Clinical electrophysiological, immunological and Virological studies in Landry's Gillam Barre (LGB) Syndrome.	DG. ICMR Multi-Institutional
17.	Studies on Immunological Aspects of Typhoid Fever	Dr.Ramesh Kumar AIIMS, New Delhi.
18.	Interaction between nutrition, immunology and drug response in humans: A critical study.	Dr(Mrs)Nilima Seth & A Kahirsagar, GS Medical College and KEM Hospital, Bombay.
19.	Study of type specific and type common antigens of Herpes Simplex Virus Types 1 and 2 by monoclonal antibodies prepared by Hydridoma technique.	Dr.Pradeep Seth AIIMS, New Delhi.
20.	Circulating immune complexes in Leukaemias and Lymphomes.	Dr.Manorama Bhargava AIIMS, New Delhi.
21.	Mechanism of immunogenesis and immunoregulation	Dr.VK Muthukaruppan, MKU, Madurai.

FERMENTATION TECHNOLOGY

1.	Inherent adaptive characteristics of Thermophillic fungi and their possible industrial applications.	Dr.R.Maheshwari IISc., Bangalore.
2.	Bio-conversion of cellulosic wastes into protein rich food and industrially useful chemicals.	Prof. PJ Vithayathil IISc Bangalore.
3.	Studies on carotenogenesis by Blakeslea trispora with emphasis on stimulatory factors of carotene production to increase the yield of B-Caroteneobtained by fermentation of indigenous substance.	Prof. VV Modi, MS University, Baroda.

4.	Utilisation of enzymes from Thermorphilic organisms for optimum Saccharification of sugarcane Bagasse.	Dr.R. Maheshwari. IISc, Bangalore.
5.	Thermophilous fungi and Actinomycetes and their antibiotics.	Dr.BN Johri, Bhopal University, Bhopal.
6.	Biosynthesis of Mycobacillin fermentation technology.	Dr.SK Bose, Calcutta Univ., Calcutta.

GENETIC ENGINEERING

1.	Application of Genetic Engineering techniques to the studies of biological nitrogen fixation.	Dr.S.Ghosh, Bose Institute, Calcutta.
2.	Cloning the structural genes of restriction endonucleases Eco RI and Eco R II	Dr. SM Hadi AMU, Aligarh.
3.	Construction of Mycobacterium leprae DNA library and cloning of DNA encoding the hormones hCG and human placental lactogen.	Dr.S.Bhattacharya and Dr.GP Talwar, NII, New Delhi.
4.	Molecular cloning and sequencing the genes coding for restriction and anti-restriction proteins in E.Coli and Shigella dysenteriae	Dr.K.Dharmalingam MKU, Madurai.
5.	Application of DNA splicing techniques for the insertion of bacterial nitrogen fixing genes into mitochondrial DNA of plants.	Dr.HK Das, JNU, New Delhi.
6.	Genetic manipulation in Mycobacteria and Escherichia	Dr.K.P.Gopinathan, IISc. Bangalore.
7.	Recombinant DNA techniques; cloning of genes of the bacteriophage MB 78 and Rnase I and E.Coli	Prof.M.Chakravarty, BHU, Varanasi.
8.	Application of genetic engineering to insert certain genes of fundamental and applied importance to Bacteria and to study their expression.	Prof.BB Biswas, Bose Institute, Calcutta.

9.	Programme on Genetic Engineering.	Prof.H.Sharat Chandra & Prof.TM Jacob, IISc., Bangalore.
10.	Programme (Training) on recombinant DNA technique.	Dr.NK Notani, BARC, Bombay.
11.	Training programme on recombinant DNA technique.	Dr.Maharani Chakravarty, BHU, Varanasi.

STATUS OF BIOTECHNOLOGY IN INDUSTRY

PREAMBLE

It has come to light that various Universities/Institutions/Industries in the country are actively engaged in research in the biotechnology field. However, no detailed information on their activities are known. With the establishment of the National Biotechnology Board, it has become permenant to know the status of Biotechnology in the country. Keeping in view the various kind of information in the Biotechnology field to be available at a single place, a detailed Questionnaire was prepared and issued to various Central and State Government Ministries/ Institutions/National Laboratories/Public and Private Sector Industries, for completion and returned to the Board.

2. A list of the Ministries/Institutions/Laboratories/Firms to whom the questionnaire has been issued has been prepared. The replies received from the various organisations falls under the following categories:

A Active in Biotechnology field and accordingly the questionnaire has been filled up.

B Not active in Biotechnology field but still the questionnaire has been filled up.

C Questionnaire not filled-up since not in the Biotechnology field.

D Not active in Biotechnology field but envisaged to be in the field in future.

E The questionnaire will be filled-up later.

F Not replied at all.

3. On the basis of the informations supplied by filling-up the questionnaire by the organisations active in biotechnology field a compilation in the form of a booklet has been done.

4. It is expected that the above compilation will be very useful.

I CENTRAL GOVERNMENT

1 MINISTRY OF HEALTH & FAMILY WELFARE, CENTRAL LEPROSY TEACHING & RESEARCH INSTITUTE, CHENGALPATTU, TAMIL NADU.

1.1 Date of Reply:

19th October 1982

1.2 General Informations:

1.2.1 Government of India Institution.

1.2.2 Leprosy patient care, research in all respect of leprosy, training of all categories of personnel working in the field of leprosy.

1.2.3 Proposed to start M.D., Diploma course in Leprosy; Epidemiology of Leprosy course and several other courses in Madras University in collaboration with Jawahar Lal Institute.

1.3 Expenditure in Biotechnology:

No separate account of expenditure in R&D work is given.

1.4 Manpower Employed:

Science & Technology	: 66
Administration	: 25
Others	: 94
Total	: 185

1.5 Comments/Suggestions:

NIL

2 NATIONAL RESEARCH DEVELOPMENT CORPORATION OF INDIA, NEW DELHI.

2.1 Date of reply:

6th November 1982

2.2 General Informations:

It is a public sector unit under administrative purview of DST, set up with the main objective of interfacing the R&D activities in the country with industry for commercialising indigenously developed technologies.

It is engaged in the, transfer of technology generated from public funded research institutions such as ICMR, CSIR, ICAR etc., development/upscalling of technologies in collaboration with industries; setting up semi-commercial/commercial plants based on indigenous technologies on turnkey basis. Export of indigenous technologies; development and demonstration of appropriate technologies; invention promotion and allied activities.

2.3 Activity in Biotechnology:

NRDC has been set up mainly for the developments/upscaling, commercialisation and transfer of technologies developed by public funded research institutions, private research laboratories, universities, IIT's; individual inventors etc. During the last three decades, more than 1,000

processes have been licensed to various industries in the field of drugs & pharmaceuticals, pesticides & herbicides, paints and varnishes, leather chemicals, food technology, agro-based products, electrical/ electronic instruments, machinery, etc. The processes/technologies, referred are being evaluated initially and licensed for commercial production. Where the technologies are being adequately developed for taking up commercial production, NRDC will take up further development/upscaling of such technologies before transferring for commercial production. The technologies so transferred include many items in biotechnology area. Some of the important items are given below:

2.3.1 Citric Acid:

Technology developed by RRL(Jammu) for citric acid by fermentation of sugar molasses was assigned to NRDC for commercialisation. The laboratory had carried out trial runs with 4000 litre capacity fermenters. After the initial evaluation of technology developed, the corporation has entered into equity participation with M/s Andhra Citrates for setting up a commercial plant for citric acid of capacity 25,000 litres with a total investment of Rs. 165 lakhs. The plant is expected to go into production shortly. This is a major technological break through in the production of Citric Acid by the fermentation process for the first time, based on indigenous technology.

2.3.2 Calcium Gluconate:

The RRL(Jammu) had referred the process developed in their laboratory for the manufacture of Calcium Gluconate by fermentation of glucose. The laboratory had carried out trial runs with 500 litres fermentors. NRDC after making the preliminary evaluation of the technology, has decided to enter in equity participation with M/s Punjab Cluconate Ltd., for setting up a commercial plant for the production of calcium gluconate of capacity 150 TPA with a total investment of Rs. 76 lakhs.

2.3.3 Alcohol from Tapioca:

The technology developed for the production of Alcohol from tapioca by the Central Food Technological Research Institute, Mysore and Central Tuber Crop Research Institute was referred to this corporation for commercialisation. The know-how developed was for a capacity of 25 Kg/ batch. After preliminary evaluation of the technology the corporation has decided to set up a pilot plant for proving the technology. In this connection, a consultant has been appointed for preparing a feasibility report.

2.3.4 Blue Green Algae (Photo Synthesis):

The IARI, Delhi, has referred the process for producing blue green algae (BGA) by photosynthesis process. The BGA will fix nitrogen from atmosphere and are suitable for application on rice crops as a fertilizer. The use of BGA reduce considerably the use of Nitrogen fertilizers which are produced at a higher price.

NRDC, in collaboration with N.D.D.B. (National Diary Development Board) is setting up a demonstration unit at a cost of Rs. 2.77 lakhs for the production of Blue Green Algae.

2.3.5 Bakers Yeast:

The process developed by the Central Food Technological Research Institute, Mysore, for the manufacture of Bakers Yeast was referred to NRDC for commercialisation. The corporation after making preliminary evaluation of the technology, has licensed the know-how to 3 commercial units which are regularly producing the items.

2.3.6 Tonic Wine:

The process developed for the manufacturing of Tonic Wine by the Central Food Technological Research Institute has been evaluated and licensed to M/s F.K. Research Product, Mysore.

2.3.7 Enzyme Bates:

The process developed by the Central Leather Research Institute has been evaluated and licensed to 4 parties for commercial production.

2.4 Expenditure in R&D:

Informations not given.

2.5 Manpower employed:

Science & Technology	:	36
Administration	:	15
Others	:	83
Total	:	174

2.6 Infrastructure facility available:

Informations not given.

2.7 Comments/Suggestions:

NRDC shall be involved in the activity of the National Biotechnology Board with particular reference to interfacing the R&D activities with production and commercialisation of the know-how.

Recently Ministry of Health have entrusted the responsibility of development/upscalling and transfer of technologies developed/being developed by the research institution under their Ministry. Also, NRDC has been given the responsibilities of commercialising the know-how developed in projects funded by DST under their various schemes i.e. SERC, GRF, etc. These include a number of processes in the area of Biotechnology.

NRDC with its expertise in the area of technology transfer can play a significant role in bringing the above technologies for commercial production.

II STATE GOVERNMENT

1 DIRECTOR OF CINCHONA & OTHER MEDICINAL PLANTS, WEST BENGAL.

1.1 Date of Reply:

22nd February 1983

1.2 General Information:

1.2.1 Production and improvement of Medicinal and Aromatic Plants and their active principles.

1.2.2 A full-fledged Directorate of Commerce and Industries Department, Government of West Bengal.

1.3 Activity in Biotechnology:

1.3.1 Achievements:

The projects/programmes chemical/microbiological conversion of Quinine-Quinidine; improvement of pharmacopoeial methods and Histo-chemical studies of Steroid raw materials; different areas of developmental physiology of medicinal and aromatic plants involving improvement behavioural growth, reproductive analysis, and assimilation patterns leading to enhanced synthesis of different active principles, modification and mutational studies of medicinal plants to increase yield; Soil/growth analysis; elucidation of biosynthesis patterns of active principles in Medicinal plants and experiments with radio active Isotopes.

1.3.2 Emitine extraction technology developed by the research group of the organisation has been utilized in the newly established Emetine Factory. The technology developed is one of the best-operations technologies elsewhere.

1.3.3 Modernisation of existing Quinine Factory by employing a closed circuit Tolerance Technology has been taken up in hand and is expected to be completed by 1985. Programme for conversion of Quinidine on commercial scale will be undertaken, within a year or so.

1.3.4 A new Diosgenin Factory has been started during the end of last year using the Technology from RRL, Jammu (CSIR).

1.3.5 The future programme envisages production of 16-DPA and further down-stream products by 1984-85.

1.3.6 Total Research Publications - 164.

1.3.7 Main Products Manufactured:

Quinine and its salt, Emetine Hydrochloride and Diosgenin.

1.4 Expenditure in R&D:

Roughly 4 - 6 lakhs directly and several lakhs indirectly.

1.5 Manpower Employed:

Science & Technology	: 22	
Administration	: 26	
Others	:5053	(4800 labourers)
Total	:5101	

Out of the total, 4 Ph.D'S are working in Production and R&D, and 6 Master degree holders are working in R&D in the field of biotechnology.

1.6 Infrastructure facility available:

Information not given.

1.7 Comments/Suggestions:

1.7.1 The unique opportunity of this organisation is its placement in such regions where some commercial medicinal plants can only be grown extensively. North Bengal hills use vast resources of medicinal plants and organ growth of a comprehensive research and developed compacts will certainly promote the basic cause of medicinal plants industry in India. The areas offer distinct patterns; variation and other topographical/environmental echo system. And it is possible to organise R&D activities on some very specific crops of commercial importance which are likely to earn sizeable foreign exchange.

1.7.2 The organisation will consider sponsoring specific R&D work in any other R&D Centre in India as the collaboration/exchange of scientific personnels/expertise will improve the overall R&D functioning. The organisation has identified the RRL laboratories of CSIR, CIMAP and agricultural universities as ideal place for collaborative R&D work.

2. MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE, PUNE, MAHARASHTRA.

2.1 Date of Reply:

15th December, 1982.

2.2 General Information:

Conducting scientific Research in Biometry, Botany, Chemistry, Genetics and Plant Breeding, Geology and Palaeontology, Microbiology, Mycology, and Plant Pathology and Zoology.

2.3 Activity in Biotechnology:

Conducting Research in the different fields of biotechnology like Biometry, Botany, Chemistry, Genetics, Plant-breeding, Geology, Plaeonotology, Microbiology, Mycology, Plant Pathology, Zoology, Instrumentation and library facilities are available for the purpose.

About 1200 research papers based on the data collected at this institute have been published in different journals of repute in India and other countries. Journals "Biovigyanan"(Journal of life sciences) has been publishing since 1976 from the MACS.

Number of Project/research schemes sponsored by ICAR, CSIR, UGC, DST and other Scientific organisations of Government of India has been carried out. State Government helped in form of land for its campus and for its experimental farms.

2.4 Expenditure in R&D:

Past: Rs. 13.57 lakhs, Rs. 22.37 lakhs, Rs. 79.33 lakhs in 1979-80, 1980-81 and 1981-82 respectively.

Present: Rs. 57.67 lakhs in 1982-83.

2.5 Manpower employed:

Science & Technology	:	42
Administration	:	24
Others	:	77
Total		143

2.6 Infrastructural facility available:

Informations not given.

2.7 Comments/Suggestions:

NIL.

III NATIONAL LABORATORIES

1 BLOOD GROUP REFERENCE CENTRE, BOMBAY, MAHARASHTRA.

1.1 Date of Reply:

22nd November, 1982.

1.2 General Information:

Diagnostic services/full time research.

1.3 Activity in Biotechnology:

Following research programmes has been made since 1957.

1.3.1 Blood Group Serology:

This division has been functioning since 1957 and is concerned with identification of blood group antibodies in cases of difficult cross-matching of bloods, multiple transfusion as well as pregnancy. There is also an Antenatal Diagnosis unit which screens all Rh negative pregnant women and assists in the diagnosis of jaundiced infants.

1.3.2 Transplantation Biology:

This Division started in 1969 is responsible for developing histo-compatibility antigens (HLA) technology. The service component caters to cross-matching procedures in cases of renal transplantation from the city hospitals as well as from other parts of India. The research component relates to the study of various HLA antigens association with infections and other diseases.

1.3.3 Immunology:

This division has been dealing with the Immunoglobulin analysis of various haematologic disorders since 1974. Apart from diagnostic service facility this division has been conducting original research on Ig structure and function in neoplastic disorders of hematologic origin such as multiple mycloma, various types of leukemic and lymphoma. A new section on Immunofluorescence has been started from 1980.

1.3.4 Hepatitis:

The division established in 1970 studies referred cases of viral hepatitis and post transfusion hepatitis (PTH) for hepatitis B surface antigen (HBs'AG) anti HB_s, HB_eAg and anti HB_e. The division is also developing sensitive kits such as reversed passive homagglutination (RPHA) for testing HB_sAg.

1.3.5 Enzymopathies:

The division has been investigating referred cases of nonspherocytic anemia for possible red cell enzyme difficiency since 1958. Most commonly found enzyme defect among these cases is that of glucose-6-phosphate dehydrogense (G6PD). Systematic research carried out has revealed that abnormal red cell componant(s) may be aiding in hemolytic process besides the basic defect.

1.3.6 Haemoglobinopathies:

This division was started in 1978 with a view to develop procedures for abnormal hemoglobins and thalassemias. The research aspects deal with abnormal chains involved in heamoglobin biosynthesis.

1.3.7 Anthropology:

This division has been carrying out field studies on various urban population and tribal groups in different parts of India since 1957. The genetic markers including many blood group systems (A1A2BO, Rh including, suntypes, MNS, Kell, Duffy and others) abnormal heamoglobins, G6PD deficiency etc.

All these divisions are concerned in developing future projects pertaining to their specialities.

1.4 Expenditure in R&D:

Informations not given.

1.5 Manpower employed:

Science & Technology	:	19
Administration	:	8
Others	:	11
Total	:	38

Out of the above, there are 20 R&D personnels working in the field of immunology.

1.6 Infrastructure facility available:

Informations not given.

1.7 Comments/Suggestions:

Institutions compare their existing technologies with the advanced countries.

2 CENTRAL RESEARCH INSTITUTE, KASAULI, HIMACHAL PRADESH.

2.1 Date of Reply:

1st March, 1983.

2.2 General Information:

Production, Quality Control, Training and Research.

2.3 Activity in Biotechnology:

2.3.1 Production:

Production of immunobiologicals viz., DPT, DT, TT, antityphoid; Antirabies, Yellow Fever Vaccine, Cholera Vaccine, Antisera and Diagnostic Reagents/Antigens. Only Institute in South East Asia Region for production of Yello-Fever-Vaccine. An agreement has been reached between the Government of India and Government of Japan for the manufacture of Japanese Encephalitis Vaccine. The Project is passing through the initial stage of finalisation.

2.3.2 Quality Control:

The Institute is recognized Central Government Laboratory for the testing of immunobiologicals for vaccines produced at other laboratories

in India or imported from abroad, as also for the Drug Control Administration of various states and Union Territories, and the Drug Control of India. The biological Standardization and Quality Control of the Institute also prepares national reference standards calibrated against international standards for supply to all manufacturing institutes free of cost. Standards tetanus anti toxin, standard diphtheria anti-toxin, standard diptheria anti-toxin for flacculation, standard gas gangrene, anti-toxin standard, standard antirabies vaccine are the standards prepared and supplied by this institute. Work on production of national reference standards for other vaccines and sera is in progress. Neurovirulence testing of Polio vaccine now imported and to be manufactured by the Haffkine Bio-pharmaceutical Institute, Bombay, is being done at the Institute. This institute also acts as National Yello-Fever Vaccine National Collection of Type Cultures Centre and National Influenza centre.

2.3.3 Training:

The institute trains candidates sponsored by WHO, other international agencies and Vaccine production organization in the country in the techniques of production of various vaccines and sera and their quality control. Besides regular courses, short-term courses, also conducts for diagnosis, prevention and treatment of rabies, quality control of vaccines and sera and training courses for Drug Control Officer. The various training courses organised by the institute are as follows:

2.3.3.1 Training course in Diagnosis, prevention and treatment of rabies.

2.3.3.2 Training course of drugs control officers in the manufacture and testing of vaccine.

2.3.3.3 Vaccine course in production of S&V.

2.3.3.4 Trainees from different organisations trained in the production of S&V apart from the above courses.

2.3.4 Research

Research studies of medical importance are being conducted regularly to improve the techniques of production and quality control of the vaccines and for production of more efficacious and lesstoxic vaccines and sera. Study on sera conversion after measles vaccination in children is being continued alongwith the potency testing of the improved vaccine. Continued efforts are being made to develop newer vaccines like measles vaccine. Rat brain Antirabies Vaccine, Tissue Culture Antirabies vaccine etc., Research on the on-going projects of stability of Tetanus Toxoid and pertussis Vaccine, Lypopolysaccharide fraction of B. Parapertussis and Type specific agglutinin response against pertussis vaccine is being continued.

2.4 Expenditure in R&D:

Past: Rs. 117.58 lakhs; 126.39 lakhs; 139.17 lakhs in 1979-80, 1980-81 and 1981-82 respectively.

2.5 Manpower Employed:

Science & Technology	:	162
Administration	:	68
Others	:	415
Total	:	645

2.6 Infrastructure Facility Available:

The national requirement of vaccine and sera for combating and containing the communicable diseases and thus massive production of these products at this Institute relegated the research activities to significantly low levels and hence the Government of India acquired the erstwhile estates of L.L. Sanatorium for establishment of a separate Research & Training Wing of this Institute in 1976. The process of re-adaptation of the buildings for the purpose is vase space and the departments of Parasitology, Mycology and Mycobacteriology have already been established. A beginning has also been made in establishment of Immunology Division and Biochemistry Division.

2.7 Comments/Suggestions:

NIL

3 INDIAN INSTITUTE OF PETROLEUM, DEHRADUN, UTTAR PRADESH.

3.1 Date of Reply:

19th November, 1982.

3.2 General Information:

Institute has only one project related to the production of single-cell protein from petroleum paraffins and other sub-strates. This project being carried out at the Koyali Refinery in Baroda.

3.3 Activity in Biotechnology:

Not mentioned separately.

3.4 Expenditure in R&D:

Informations not given.

3.5 Manpower Employed:

Informations not given.

3.6 Infrastructure facility available:

Not mentioned.

3.7 Comments/Suggestions:

This institute has established a pilot-plant and other related laboratory facilities for this work.

4 INDIAN INSTITUTE OF TECHNOLOGY, NEW DELHI.

4.1 Date of Reply:

11th December, 1982.

4.2 General Informations:

4.2.1 Teaching & Research.

4.2.2 Autonomous government organization.

4.3 Activity in Biotechnology:

Some of the major projects on Biotechnology of renewable resources which are being investigated intesively include pretreatment of cellulosic materials, simultaneous saccharification and rapid fermentation of agro-residues to alcohol, direct fermentation of cellulosic materials into ethanol, microbial production of butanolacetone from enzymatically hydrolysed cellulose, development of immobilized whole cell reactors for rapid production of ethanol, mixed culture fermentation for cellulose and hemicellulose production, ethanol separation and improvement of industrial micro-organisms through genetic manipulation.

4.4 Expenditure in R&D:

As per Institute Rules.

4.5 Manpower Employed:

Science & Technology	:	20
Administration	:	5
Others	:	NIL
Total	:	25

Out of the above there are 4, 10 and 21 R&D personnels working in the field of Genetic Engineering, Enzyme Engineering, and Microbial Engineering (including Alcohol Fermentation) respectively.

4.6 Infrastructure facility available:

Not furnished.

4.7 Comments/Suggestions:

Three of the most important core areas of current biotechnology R&D are missing from the listed areas. These are microbiological, engineer-

ing, bioreactors, and process control. None of the other areas mentioned can take care of these and, in fact the development of biotechnology will continue to remain throlled in absence of any of these areas. It is therefore suggested that these areas be included in the list. Related to this point it is also felt that inclusion of 'alcohol fermentation' seems to be out of place. There are so many other areas of fermentation which also be listed like alcohol fermentation and as a result the list would become very large and apparently unnecessary. If therefore the list is confined to the various areas of this discipline rather than technologies, then biotechnology will be covered properly.

Microbial growth modelling, dynamic control of enzyme synthesis and release; low energy separation processes; immobilized enzyme & whole cell reactors; hyper production of primary & secondary metabilities; metabolic regulation of gene function; Primary thrust for application of all these areas will be in the field of biotechnology of renewable resources.

5 NATIONAL INSTITURE OF VIROLOGY, PUNE, MAHARASHTRA

5.1 Date of Reply:

22nd December, 1982.

5.2 General Information:

Scientific Research Centre

5.3 Activity in Biotechnology:

5.3.1 Development of arboviral vaccines, ELISA, Interferon.

5.3.2 Publication of 145 papers on Virology, Entomology, Pathology, Hepatitis, Rickettsiology, etc. (out of which 17 & 90 research publications are in Tissue culture and Immunology respectively).

5.3.3 Number of projects/programmes- Three in Tissue culture.

5.3.4 Area of envisaged growth and diversification-

5.3.4.1 Viral vaccines, monoclonal antibodies, Diagnostic reagents, Interferon:

Investigation in attenuated strains of JE virus for use of vaccine continued and strain (G 8924) also included in it. Development of an ELISA by hepatitis B virus antigen and antibody to hepatitis B surface Ag prepared. Availability of Tissue Culture facilities, Substitution of foetal bovine serum from foetal goat serum has been made. A substrain of BHK-21 cell line adopted to goat serum. New method for detection of antibodies in sera of sentinal animals, dengue and JE viruses developed.

5.3.4.2 Malaria Scheme "Invitro cultivation of Malaria Parasites"

Strain (FMN-13 and FMN-17) and several substrains of P. falciparum, method of cultivation and storage of malaria parasite culture has been developed.

5.3.4.3 DST project "Evaluation of Indigenous Interferon Inducers and anti-viral drugs for Prophylactic and Therapeutic use in Man".

5.3.5 Progress made in 1982-83, and future programme for 1983-84 are given as follows:

Technical programme 1982-83:

Laboratory standard of humanleukocyte interferon and anti serum to human leukocyte interferon has been prepared. Expertise in assay of human mouse and monkey IFN using indigenous materials in WISM, L.M. and human embryonic skin fibroplast cells has been achieved.

Programme in 1983-84:

Programme in 1983-84:

Studies will be continued for antiviral (especially against JE) evaluation of 6 MFA produced by Hindustan Antibiotics Ltd., screening for interferon therapy in cancer cares and clinical trial of interferons in cancer, viral enceplalities contemplated.

Efforts will be made for clinical evaluation of human leucocyte interferon produced in the laboratory. Various interferon inducers including lectins and nitrogens will be screened for interferons including ability in mice. Studies on formalised JE vaccine will be continued. Live vaccine strains will be studied. Efforts will be made to standardize hybridoma technology to Rabies monocolonal antibodies against several viruses of public health importance.

5.4 Expenditure in R&D:

Past: Rs. 74.03 lakhs. Rs. 94.10 lakhs, Rs. 93.0 lakhs in 1979-80; 1980-81 and 1981-82 respectively.

Present: Rs. 112.40 lakhs in 1982-83.

5.5 Manpower employed:

Science & Technology	:	227
Administration & others	:	136
Total	:	363

Out of the above, 227 R&D personnels are working in the field of biotechnology.

5.6 Infrastructure facility available:

Informations not given.

5.7 Comments/Suggestions:

5.7.1 Better coordination with appropriate services within the country and abroad.

5.7.2 Actual workers should be included in the Biotechnology Board not merely by designation.

6. REGIONAL RESEARCH LABORATORY, JORHAT, ASSAM.

6.1 Date of Reply:

15th October, 1982.

6.2 General Information:

Nature of work is Research & Development under CSIR.

6.3 Activity in Biotechnology:

6.3.1 Project Title:

6.3.1.1 Production of Industrial Enzymes.

6.3.1.2 Microbial conversion of sterol to C-19 Steroids.

6.3.1.3 Mechanism of Microbial uptake of Hydrocarbon.

6.3.1.4 Management of water hyacinth.

6.3.1.5 Immunological approaches to fertility control specially in males.

6.3.2 Area of Envisaged growth & Diversification:

6.3.2.1 Enzyme Engineering for the production of Industrial enzymes.

6.3.2.2 Microbial strain improvement through conventional mutation & recombinant gene technique specially in connection with steroid transformation & industrial enzymes production.

6.3.2.3 Biomass conversion to energy.

6.3.2.4 Immunological studies for production of antifertility agents.

6.4 Expenditure in R&D:

Rs. 6.96 lakhs in 1982.

6.5 Manpower Employed:

Total : 19

6.6 Infrastructure facility available:

List enclosed.

6.7 Comments/Suggestions:

They would like to use in-house technology facility available in Indi and help other R&D institutions in India.

7. REGIONAL RESEARCH LABORATORY, TRIVANDRUM, KERALA

7.1 Date of Reply:

6th & 18th October,1982.

7.2 General Information:

Annual Report for the year 1981 has been enclosed with the letter, to give the idea of the Nature of activities of this isntitution, R&D activities are in the field of food, material sciences and ceramics.

7.3 Activity in Biotechnology:

7.3.1 Utilization of cassava starch and the wastes generated during starch processing forthe productiion of biofules and single cell proten. Studies pertaining to continuous fermentation and development of yeast cell immobilised reactor for ethanol production. Studies related to development of indigenous technology - in the field of HFS (High Fructose Syrup) from 1.4.1983.

7.4 Expenditure in R&D:

Particulars not mentioned.

7.5 Manpower Employed:

Information not given.

7.6 Infrastructure facility available:

Not mentioned.

7.7 Comments/Suggestions:

NIL

8. TUBERCULOSIS RESEARCH CENTRE, CHETPUT, MADRAS

8.1 Date of Reply:

November,1982.

8.2 General Information:

Medical Research on Tuberculosis.

8.3 Activity in Biotechnology:

The achievements of research work are helpful to National Tuberculosis programme for formulation of treatment regimens for the masses in various regions in the country.

No. of Research Publications - 33
No. of Project/programme - 5

The objectives of the Centre were broadened to include the evolution of inexpensive and effective chemotherapeutic regimens capable of mass application and related bacteriological, biochemical and epidemiological, biochemical and epidemiological studies. The twenty-five years of its existence have witnessed an outstanding record of achievements through a series of carefully designed controlled clinical trials executed with meticulous care and analysed according to stringent statistical criteria. Through these studies the Centre has earned international reputation as an institute of excellence and has helped to established principles of chemotheraphy which have also been adopted in fields other than tuberculosis. The future programmes of the Centre till the end of the Sixth Five Year Plan are as under:

1982-83

1. Continuation of chemotheraphy trials in tuberculosis and epidemiological studies in tuberculosis;

2. Establishment of Histopathology department;

3. Evaluation of drug-regimens in Tiruvellore and surrounding rural areas;

4. Conduct of study on abdominal tuberculosis.

1983-84

1. Continuation of clinical & Laboratory studies in tuberculosis;

2. Conduct of Electron-Microscopy studies in tuberculosis;

3. Establishment of International Training programme for providing training in Epidemiology and control of communicable diseases such as tuberculosis, Leprosy and Filariasis;

4. Conduct of studies in experimental tuberculosis in animals;

1984-85

1. Continuation of clinical and laboratory studies in tuberculosis;

2. Strengthening of International Training Programme; and

3. Continuation of epidemiological studies in tuberculosis.

The achievements of research work are helpful to the National Tuberculosis Programme for formulating of treatment regimens for the masses in various regions in the country.

8.4 Expenditure in R&D:

Past : Rs.46.32 lakhs; Rs.63.94 lakhs, Rs.85.22 lakhs in 1979-80, 1980-81 and 1981-82 respectively.

Present : Rs.138.42 lakhs in 1982-83.

Future : Rs.309.55 lakhs in 1983-85.

8.5 Manpower Employed:

Science & Technology	: 192
Administration	: 42
Others	: 71
Total:	:305

8.6 Infrastructure facility available:

Equipment and other facility available has been mentioned.

8.7 Comments/Suggestions:

NIL

9. VECTOR CONTROL RESEARCH CENTRE, PONDICHERRY, UNION TERRITORY

9.1 Date of Reply:

24th November, 1982.

9.2 General Information:

Vector Control Research Centre under ICMR.

9.3 Activity in Biotechnology:

9.3.1 Projectwise and Future Programmes:

9.3.1.1 Isolation, culturing and Mass-production of Bacteria, Fungi, (insect pathogens).

9.3.1.2 Plant extracts as Mosquito larvicides.

9.3.1.3 Plant Materials for preparing antimosquito coils.

9.3.1.4 Utilisation of fish for mosquito control.

9.3.1.5 Utilisation of algae for paper industry.

9.3.1.6 Pisiculture for mosquito control.

9.3.2 Progress & Achievements during 1976-81

No. of Projects/Programmes:

9.3.2.1 58 bacterial agents. Isolated and cultured out of which two reached operational stages.

9.3.2.2 17 Fungal isolates are being developed for operational use.

9.3.2.3 1 Romanomerimis iyengeris is already used in field for biological control of mosquito.

9.3.2.4 Anisops boravi already used for mosquito control.

9.3.2.5 Toxorphynchitis splendes one of the non-biting mosquito already in use for mosquito control in rural areas with the help of community.

9.3.2.6 Fishes are extensively used in causarina pits of coastal village and wells in Pondicherry urban areas for malaria control.

9.3.2.7 Microsporidians are being exploited for preventing malaria transmission.

9.3.2.7 Microsporidians are being exploited for preventing malaria transmission.

9.3.2.8 Plant extracts are basing and as synergist in combination with the insecticide.

9.3.2.9 Plant material and as mosquito repellant to reduce man vector contact.

9.3.2.10 Algae which prevent predstion of mosquito by fishes are being utilised for manufacturing paper as a result socio economic condition of the vallager are improving and the community is participati ng mere in vector control programmes.

9.3.3 Technology developed in the field of biotechnology:

9.3.3.1 The technologies developed in the field have been commercialised and handed over to paper industries. For eg., Man production of Deltox handed over to CSIR and Repellants handed over to Defence.

9.3.4 Area of envisaged growth Diversification:

Repellants, Biocides.

9.4 Expenditure in R&D;

Past : Rs.30.04 lakhs; Rs.49.93 lakhs; Rs.60.97 lakhs; in 1979-80, 1980-81 and 1982-82 respectively.

Present: Rs.52.91 lakhs in 1982-83.

Future : Rs.53.81 lakhs; Rs.53.50 lakhs; Rs.49.80 lakhs; for 1983-84, 1984-85 and 1985-86 respectively.

9.5 Manpower Employed:

Total - 72.

9.6 Infrastructure facility available:

9.6.1 Plant Extractor

9.6.2 Rotary vaccum Evaporator with vaccum pump.

9.6.3 Fermentors.

9.6.4 Thin Layer chromatograph set

9.6.5 Lyophilizerd.

9.6.6 Spectrophotometers.

9.6.7 Centrifuges.

9.7 Comments/Suggestions:

National Biotechnology Board should try the following things:

9.7.1 Prevent duplication of efforts.

9.7.2 Encourage indigenous product by preventing input of technology wherever it is available.

9.7.3 Simplifying the procedure by designing simple forms.

9.7.4 Reducing paper works.

9.7.5 The low cost production technology and easy simple delivery system which can be implemented by the community.

IV PUBLIC SECTOR

1. HINDUSTAN ANTIBIOTICS LIMITED, PIMPRI, PUNE, MAHARASHTRA.

1.1 Date of Reply:

29th November, 1982.

1.2 General Information:

1.2.1 Public Sector Company

1.2.2 Registered with DGTD.

1.2.3 Covered under IDR Act.

1.2.4 Manufacturing and selling of life saving antibiotics.

1.2.5 Technical collaboration:

S.No.	Product	Name of Technical collaboration	Ministry of collaboration
1.	Streptomycin	Glaxo Laboratory, UK.	Cut right sale
2.	Ampicillin	American Home 1 producers, U.S.	7 years Royalty-25% from the date of commercial production
3.	Penicillin	Totojozo Ltd., Japan.	5 years Royalty - lumpsum paid for know-how on strain.
4.	Gentamicin	Medimpex Ltd., Hungary	5 years Royalty-lumpsum paid for know-how on strain.

1.2.6 Main Products Manufactured:

S.No.	Product	Capacity Licensed	Installed Capacity	Actual production 1978-81
1.	Penicillin	200 mmu	200 mmu	116.8mmu (1978-79) 110.6mmu (1979-80) 109.8mmu (1980-81)
2.	Streptorycin	170 tonnes	170 Tonnes	100 tonnes (1978-79) 91 tonnes (1979-80) 91 tonnes (1980-81)
3.	Ampicillin (under commission)	35 tonnes	35 tonnes	4 tonnes (1978-79) 8 tonnes (1979-80) 7 tonnes (1980-81)
4.	Gentamicin	1 tonne	1 tonne	Trial runs are on.

1.3 Activity in Biotechnology:

1.3.1 6 APA, is in production, immobilisation of enzymes, enzyme Engineering in R&D.

1.3.2 Preparation of kit for detection of pregnancy using ELISA technique process for manufacture of amyloglucosidas, immobilized penicillin acylase to use is being upscaled in plant.

1.3.3 Development of immo-diagrothin kits for detection of Hipatitis filarious, JgG. by ELIZA technique use of proper reactor for use of immobilized enzyme. Better matrix for immobilization of P.A.

1.3.4 Progress and achievements during 1976-81:

1.3.4.1 Genetic improvement of microbial strains: (Chemical mutation) With the use of chemical mutagen, the moulds used in antibiotics production have been developed.

i) p. chrysogenium was improved to produce 15000 u/ml.

ii) Streptomyces fradiae strain producing 500 u/ml of Neomycin was improved to 8000u/ml.

iii) E.coli strain producing 5u/ml. was improved to 30 u/ml. of penicillin acylase.

iv) Aspergillus strain was improved to produce 1800u/ml. They would like to develop strains using techniques of genetic engineering such as gene cloning, recombinant DNA, protoplast fusion especially for bacterial strains and actionomycates.

1.3.4.2 Enzyme Engineering:

i) Synthesis of various conjugates involving cellulose and sepharoses as matrices and D(-) phenylglycine, Ampicillin Amoxycillin as ligands.

ii) Usage of synthesized conjugates to purify penicillin aclyase to homegenity with a specific activity of 30-35u/mg. protein.

iii) Purification of Amyloglucosidase to homogenity by affinity chromatography purified enzyme showed single based on gel electrophoresis.

iv) Improvement of Aspergillus to produce 3000 u/ml in shake flasks.

v) Process for the manufacture of bacterial dcamylase and amyloglucosidase were developed. The enzyme was isolated purified and properties studied.

vi) Process for production of dcmannosidase was developed in laboratory to give productivity of 1000-1200 u/ml. and upscaled to plant level. The use of enzyme in fermentor reduced streptomycin B level to 10% from 25% in streptomycin production.

1.3.4.3 Immunology:

Development of diagnostic kits using ELISA techniques Detection of ACG in urine using penicillinase as marker enzyme. This technique has been applied to fabricate a pregnancy detection kit.

1.3.4.4 Work under progress:

i) Process for preparation of Antibodies for sustralia antigen and process for purification of conjugate with penicillinase antisera to HBS Ag to develop a kit to detect Hepatitis.

ii) Development of a kit for filariasis in collaboration with Medical College, Wardha.

iii) IgG Antibody and conjugation with Pencillin.

1.4 Expenditure in R&D:

Past : Rs.70.32 lakhs, Rs.94.25 lakhs, Rs.85.04 lakhs and Rs.71.41 lakhs in 1978-79, 1979-80, 1980-81 and 1981-82.

Present: Rs.100 lakhs for 1982-83.

Future : Rs.152 lakhs for 1983-84.

1.5 Manpower Employed:

Science & Technology	: 460
Technical & Administration	:2072
Others	: nil
Total	:2532

Out of the above, 5 Production and R&D personnels are working in Enzyme Engineering and 2 R&D personnels are working in the field of immunology.

1.6 Infrastructure facility available:

Fermentors and reactor vessels for production. Pilot plant with fermentation facilities for R&D.

1.7 Comments/Suggestions:

Organisation would like to i) develop in-House technology for their projects. ii) Collaboration with other R&D Institutions like I.R.R.Medical College, Wardha; N.C.L. Pune, BARC, Trombay, CCMB, Hyderabad will be undertaken in the study/research in the field of Genetic Engineering.

Organisation considered to sponsoring Genetic Engineering development of strain producing enzymes to other R&D Centres in India based on the expertise available present in that place.

The immobilisation of penicillin acylase compares very well with other available technologies. The recovery of reaction product is still not.

2. HINDUSTAN ORGANIC CHEMICALS LTD, RASAYANI, MAHARASHTRA.

2.1 Date of Reply:

22nd November '82 and 8th December 1982.

2.2 General Information:

2.2.1 It is a public Limited Company.

2.2.2 Covered under IDR Act.

2.2.3 It is manufacturing Chemicals.

2.3 Activity in Biotechnology:

2.3.1 The company has sponsored a scheme with NEERI, Nagpur, to study the biodegradability of the efficients generated in the Resorcinol Recovery Plant after sulphite removed and nutratized acidic effluent from the MAP plant. Since the laboratory scale study has been encouraging, installation of pilot-plant to study in the semi-commercial scale has been suggested and necessary action in this regard has been initiated.

2.3.2 Areas of envisaged growth and diversification have been suggested as PTFE, MDI, Biochemicals in long range.

2.4 Expenditure in R&D:

The company has sponsored as scheme on the only project in biotechnology. they are involved in-"Biotechnology of Effluents" with NEERI, Nagpur. On encouraging laboratory results a prospect proposal to instal a pilot-plant at a cost of Rs.3 lakhs is under active consideration.

2.5 Manpower employed:

Science & Technology	:	853
Administration	:	215
Others	:	470
Total:	:	1538

Infrastructure facility available:

Good analytical facilities available.

2.7 Comments/Suggestions:

Organisation like to acquired Technology from abroad.

V PRIVATE SECTOR

1. ANIL STARCH PRODUCTS LTD., AHMEDABAD, GUJARAT.

1.1 Date of Reply:

25th November, 1982

1.2 General Information:

1.2.1 Public Limited Company.

1.2.2 Registered with DGTD and covered under IDR Act.

1.2.3 Covered under MRTP Act.

1.2.4 Manufacturing starch, Dextrose, Monohydrate, Annydrous dextrose, Liquid Glucose, Sorbitol Calcium Gluconate, Industrial and Pharmaceutical Enzymes, Fertilizer, forgoings etc.

1.3 Activity in Biotechnology:

1.3.1 Manufacturing Bacterial Protease, Bacterial Alpha Amylase Fungal Anylolucosidase and Calcium Gluconate.

1.3.2 Processes for Xanthan gum and glucose Isomerase have been developed upto 50 L batch size then discontinued.

1.3.3 R&D activity on the various projects are as follows:

Pullulauase in 1979
Fungal Alpha Amylase in 1982
Culture Improvement especially the development of methods protoplast fusion in 1981.
Sodium Gluconate.

1.3.4 There are four ongoing projects/programmes are in the field of enzyme engineering.

1.3.5 Areas of envisaged growth and diversification are novel enzymes for starch modification, Enzymes used in modification of foods and feeds. Development of infrastructure needed for applying the power techniques of culture improvement to industrial micro-organism, especially Bacillus.

1.3.6 Technologies developed have been commercialised.

1.4 Expenditure in R&D

Past : Rs.6.37 lakhs, Rs.11.56 lakhs and Rs.8.61 lakhs in 1979, 1980, 1981 respectively.

Present : Rs.13.00 lakhs in 1982.

Future : Rs.11 lakhs, Rs.15.00 lakhs and Rs.16.00 lakhs in 1983, 1984, 1985 respectively.

1.5 Manpower Employed:

Science & Technology	:	162
Administration	:	106
Others	:	1214
Total:	:	1482

Out of the above the number of R&D personnels in the Genetic Engineering and Enzyme Engineering are three each respectively.

1.6 Infrastructure facility available:

Informations not given separately.

1.7 Comments/Suggestions:

1.7.1 They would adopt the in-house technology to the extent possible and may go for foreign technology to some extent.

1.7.2 Some of the existing/indigenous technologies are comparable to technologies elsewhere; viz., use of enzymes in the production dextine and gluconates. But in the field of enzyme manufacturing process the existing/indigenous technologies are inferior, however, some process/technologies may be appropriate to Indian condition.

2. BHARAT SERUMS & VACCINES, THANA, MAHARASHTRA.

2.1 Date of Reply:

19th November, 1982.

2.2 General Information:

2.2.1 Partnership concern

2.2.2 Small scale unit

2.2.3 Manufacturing biologicals.

2.3 Activity in Biotechnology:

2.3.1 Manufacturing immunolobulin and Hemostatics.

2.3.2 The firm would like to develop the technology in the in-house R&D and as well would world, like to procure, it in collaboration with other R&D institutions in India but in the financial assistance from institution in India Area of envisaged growth and diversification are in Immunology, Virology and Bacteriology.

2.4 Expenditure in R&D

The expenditure in R&D was Rs.52,000/- in 1981-82. The expenditure for Animal house was Rs.45,000/- in 1981-82.

2.5 Manpower Employed:

Science & Technology	:	76
Administration	:	20
Others	:	19
Total	:	125

Out of the above there are 6 and 10 personnels working in Immunology in the Production and R&D respectively.

2.6 Infrastructure facility available:

Informations not given.

2.7 Comments/Suggestions:

2.7.1 Liberalization of inputs and import duty for concerned institutes with R&D units.

2.7.2 Timely process of papers by institutions like CSIR, ICMR, NRDC, DST, etc. for financial assistances.

2.7.3 Due to import regulations obsolete machines are being used resulting in higher production cost.

3. CADILA LABORATORIES PVT. LTD. AHMEDABAD, GUJARAT.

3.1 Date of Reply:

8th October, 1982.

3.2 General Information:

3.2.1 Private Limited Company

3.2.2 Registered with DGTD and covered under IRD Act.

3.2.3 Deal with manufacturing of Drugs & Pharmacueticals.

3.3 Activity in Biotechnology:

Will develop in-house for corticosteroids and enzymes. Areas of envisaged growth are in Fermentation process in antibiotics - Initially Rifampicin and in corties-steroids and enzymes. For Rifampicin, technology is being acquired from abroad. Process in corticosteroids will be commercialised. Details of the activity and future programmes are as follows:

3.3.1 Since inception, the Department is engaged mainly in Microbiological transformation of steroids:

3.3.1.1 11- hydro nylaction of progerterone and other substituted programes.

3.3.1.2 Degradation of C 17 side chain to convert programmes into androstenes.

3.3.1.3 C-1 dehydrogenation.

In the course of study more than thousand microbial strains were isolated and screened for their capacity to carry out the above conversions.

The above processes is established for 11 hydroxylation of progesterone with the efficiency more than 90% at a concentration of substrate which can be commercially exploited.

3.3.2 Antibiotics:

The company has also taken steps to develop processes for life saving drugs, such as Rifampicin.

A strain of streptomyces capable of producing a small quantity of Rifampicin-B has been obtained. Improvement of strain by mutational techniques and increasing yields by changing fermentation conditions is under progress.

3.4 Expenditure in R&D:

Past : Rs.21.35 lakhs, Rs.31.58 lakhs and Rs.31.67 lakhs in 1979, 1980 and 1981 respectively.

Present : Budget for 1982 is Rs.37.50 lakhs.

Future : Rs.40 lakhs, Rs.45 lakhs, Rs.55 lakhs for 1983, 1984 and 1985 respectively.

3.5 Manpower employed:

Science & Technology	:	138
Administration	:	653
Others	:	204
Total	:	1095

3.6 Infrastructure facility available:

A list of equipments/facilities available for R&D have been listed.

3.7 Comments/Suggestions:

Asked for any suitable process for commercialisation.

4. HINDUSTAN LEVER LIMITED, BOMBAY, MAHARASHTRA.

4.1 Date of Reply:

4th November, 1982.

4.2 General Information:

4.2.1 Private Sector industry.

4.2.2 Registered with DGTD.

4.2.3 Covered under IDR & MRTP Act.

4.2.4 Manufacture of soaps, detergents, vanaspati, dairy products, animal feeds, glycerine, catalysts, casein, personal products, industrial phosphates, fine chemicals, industrial machinery, dicalcium phosphate, STPP, sulphuric acid, processed triglycerides, agricultural commodities, marine products, Ghee, Scourers.

4.3 Activity in Biotechnology:

4.3.1 R&D activities:

S.No.	Projects	Main objects	Date of Commencement
1.	Glycerol from Molasses	To produce Glycerol from molasses by fermentation.	1973-74
2.	Other chemicals by fermentation	Explore manufacture of new chemicals by fermentation from carbohydrate development.	1975
3.	Separation processes	Studies on membrane separation for the clarification of Molasses and for the concentration of glycerine water.	1980
4.	Lipids and Lipase	Explore genetic recombination methods for synthesis of single cell oil and selective hydrolysis of oils. To design specific inhibitor for Rice Bran Lipase.	1981
5.	Plant growth Nutrient	To manufacture and cell mixtalol; explore the mode of action of mixtalol.	1979

6.	Biological fertilizers	To develop biological fertilizers for leguminous/cereal crops.	1980
7.	Clonal propagation of coconut	To develop prototype of high yielding varieties of coconut and other commercial plants.	1979
8.	Bioinsecticides	To produce bioinsecticides with strains of B.thuringiensis.	1982
9.	Immunology	Investigate monoclonal antibodies for specific use in contraception, diagnosis and treatment of disease.	1981
10.	Bio-gas	To improve efficiency of Gobar gas system.	1979

Projects 2 to 9 will be continued in future.

4.3.2 Company has been technically collaborated with Alluright and Wilson Ltd., U.K., in STPP Plant Product.

4.3.3 Although the projects of Biotechnology have not reached the stage of regular manufacture, it has been necessary to produce large quantities of plant growth nutrients and Rhizobia for carrying out field trials on large-scale.

4.3.4 Progress and achievements made during 1976-81 are as follows:

Three projects/programme in Genetic Engineering, One in Photosynthesis, one in Tissue culture, One in Enzyme Engineering, three in Chemical engineering and one in Immunology have been undertaken. Three research publications have been made in the Chemical Fermentation field. Two patents have been granted in photosynthesis and one in chemical fermentation, field and two patents in Photosynthesis and one in Chemical Engineering Fermentation field are awaiting commercialisation.

4.3.5 The technology for the production of 2000 tonnes per annum of PGN will be implemented as soon as licence for its manufacture is sanctioned. A Plant for the manufacture of 150 tonnes per annum of Propionic acid from molasses is under consideration.

4.4 Expenditure in R&D:

Past : Rs.240.28 lakhs, Rs.335.05 lakhs, Rs.310.70 lakhs in 1979, 1980 and 1981 respectively.

Present : Rs.331.93 lakhs in 1982.

Future : Rs.405.37 lakhs in 1983.

Out of the above, about 20-25% of the recurring expenditure is like to go for R&D work in biotechnology.

4.5 Manpower Employed:

Science & Technology	: 900
Administration	: 900
Others	:7663
Total	:9463

Out of the total there are 41 R&D personnesl working in the bio-technology field.

4.6 Infrastructure facility available:

The details of the equipments and other infrastructure facilities available for production and R&D work has been described.

4.7 Comments/Suggestions:

4.7.1 Company wanted to develop in-house technology for the projects mentioned.

4.7.2 Company's objective will be to develop appropriate technology in relevant areas, economic in the Indian technology context, with raw materials available indigenously.

4.7.3 Company would consider to sponsor specific R&D work in any other R&D Centre in India based on the expertise present in that place.

4.7.4 The National Biotechnology Board should have as its first priority utilization of raw materials abundantly available (e.g. molasses) for the industrial fermentative production of chemicals for which processes have already been established (e.g. alcohol, acetone, propionic acid, butanol, etc.). In this area sufficient stress should be given for the development and maintenance of appropriate micro-organisms.

4.7.5 The second priority of the National Biotechnology Board should be for the identification/development of highly productive strains for the manufacture of basic antibiotics required for the country. For this purpose a nominated laboratory with facilities for developing and maintenance of highly productive strains should be maintained.

4.7.6 The third priority of the National Biotechnology Board should be for the development of immuno-diagnostic kits for diseases such as amoebiasis, infectious hepatitis, blood dyscrasias and certain

genetic disorders more prevalent such as phynylketonuria, alkaptonuria, etc. For this purpose, laboratory facilities for the preparation of antibodies through hybridoma techniques is necessary.

4.7.7 The production, maintenance and cultivation of hybrids and plants produced through photoplastic fusion are of great relevance in the context of Indian agriculture and horticulture. Facilities for these should be created but the laboratory should be part of a total system with facilities for field work and agronomic operations.

4.7.8 A 'passive' antibody for contraception, based on the principle of blocking more specifically earbohydrate-protein regions of human chorionic gonadotrophin for higher specificity

4.7.9 Use of microbes such as E.Coli, B. Subtilis and yeast as vectors for the production of expensive biologically important hormones such as insulin, growth hormones, etc.

4.7.10 Investigation on lectine relevant to the Indian environment, particularly in rhizobial legume interaction for the promotion of better productivity in pulses.

4.7.11 Membrane genetics and biochemistry, particularly with a view to understand the role of alcohols such as Vitamin 'A' and dolicnol in the transmembrane transport of sugars. This is of great importance in the understanding the treatment of genetic disease such as diabetes, arteriosclerosis, hypertension, etc.

4.7.12 Preparation of polypeptide vaccines for major infections diseases of a parasitic nature such as malaria, amoebiasis, and infectious hepatitis, foot and mouth diseases, important in Indian environment.

4.7.13 While we have enumerated some of the problems vulnerable to biotechnology approach for solutions, it should be remembered that unless some positive answers are obtained it would be futile to spread money, efforts and scientific talent in too many areas all at once. We would suggest prioritising in the order mentioned.

5. HOECHST PHARMACEUTICALS LTD., BOMBAY, MAHARASHTRA.

5.1 Date of Reply:

22nd November, 1982.

5.2 General Information:

Object of their research programme as:

There research Centre does not cover the field of biotechnology as listed in the questionnaire. The objectives of the research programmes of the firm are:

5.2.1 Search for noval pharmaceutically active drugs from Plants as well as from Chemical synthesis.

5.2.2 Search for Novel antiamoebics and antimalarials from Plants as well as from chemical synthesis.

5.2.3 Screening of microbial straining for new antibiotics and antitumor compounds.

In concentration with this programme, they have established a genetic group. This group is involved in mutation and protoplast fusion work aiming at new antibiotic producing strains and at higher producers.

5.3 Activity in Biotechnology:

Not mentioned separately.

5.4 Expenditure in R&D:

Particulars not mentioned.

5.5 Manpower Employed:

Particulars not mentioned.

5.6 Infrastructure facility available:

Informations not given.

5.7 Comments/Suggestions:

Nil.

6. SOUTHERN PETROCHEMICAL INDUSTRIES CORPORATION LTD. TUTICORIN, TAMIL NADU.

6.1 Date of Reply:

10th October 1982 and 10th November, 1982.

6.2 General Information:

6.2.1 Joint Sector with Tamil Nadu Industrial Development Corporation.

6.2.2 Covered under IDR Act.

6.2.3 Manufacturer of Fertilizers.

6.3 Activity in Biotechnology:

6.3.1 Present programmes:

The activity in the field of biotechnology in SPIC commenced only very recently. The help of Tamil Nadu Agricultural University was sought to set up the microbiological laboratory. From August 1982, full fledged work commenced with one well-qualified microbiologist assisted by two technicians:

The following biotechnological works are under progress:

6.3.1.1 Microbiological treatment of urea plant effluent based on enzymatic hydrolysis system using urease.

6.3.1.2 Microbiological production of sulphur from phosphogypsum.

6.3.1.3 Production of chromium (IV) by bacterially produced hydrogen sulphide.

6.3.1.4 Production of single cell protein for animal food from waste waters.

6.3.2 Future Programmes:

6.3.2.1 Biotechnical products and applications (Production of insulin interferon, etc.).

6.3.2.2 Hybrid/Biofertilizer development.

6.3.2.3 Microbiological catalysed chemical reactions and their application in the industry.

6.3.2.4 Unconventional method of Ammonia production.

6.4 Expenditure in R&D:

Past : Rs.31.8 lakhs, Rs.36.00 lakhs, Rs.52.00 lakhs in 1979-80, 1980-81 and 1981-82 respectively.

Future : Rs.90 lakhs, Rs.258 lakhs in 1982-83 and 1983-84 respectively.

6.5 Manpower Employed:

Science & Technology	:	838
Administration	:	381
Others	:	52
Total	:	1171

6.6 Infrastructure facility available:

Certain infrastructure facilities exhisit for undertaking R&D in biotechnology. The microbiological laboratory has been set-up with the help of Tamil Nadu Agricultural University. A list of equipments available has been given.

6.7 Comments/Suggestions:

The services to be provided by the National Biotechnology Board should include- journals and manuals, Seminars and referesher course, topical lectures, Technical visits, Annual conventions, Data, Bank, Review of literature and regulations and services of experts apart from independent research.

LIST OF MAJOR SCIENTIFIC AND TECHNOLOGICAL INSTITUTIONS IN INDIA WORKING IN THE FIELD OF BIOTECHNOLOGY:

	Name of Organisation/Institution	Administrative Ministry/ Department/Agency
BOMBAY		
1.	Bhabha Atomic Research Centre	Atomic Energy
2.	Tata Institute of Fundamental Research	-do-
DELHI		
3.	National Institute of Immunology	DST
4.	Centre for Biochemicals	CSIR
5.	National Bureau of Plant Genetic Resources	ICAR
6.	Indian Agricultural Research Institute	ICAR
7.	Immunology Research and Training Centre	ICMR
8.	Malaria Research Centre	ICMR
9.	National Institute of Communicable Diseases	Health & Family Welfare
10.	National Institute of Health & Family Welfare	-do-
CALCUTTA		
11.	Bose Institute	DST
12.	Indian Institute of Chemical Biology	CSIR
13.	Jute Technological Research Laboratory	ICAR
14.	Cholera Research Centre	ICMR
15.	School of Tropical Medicine	Health & Family Welfare

MADRAS		
26.	B.C.G. Vaccine Laboratory	Health & Family Welfare
HYDERABAD		
27.	Regional Research Laboratory	CSIR
28.	Centre for Cellular & Molecular Biology	CSIR
29.	Indian Drugs & Pharmaceuticals Ltd.	Chemicals & Fertilisers
BANGALORE		
30.	Indian Institute of Horticultural Research	ICAR
31.	National Tuberculosis Institute	Health & Family Welfare
POONA		
32.	National Chemical Laboratory	CSIR
33.	Maharashtra Association for the Cultivation of Science	DST
34.	National Institute of Virology	ICMR
35.	Hindustan Antibiotics (Pimpri)	Chemicals & Fertilisers
DEHRADUN		
36.	Forest Research Institute & College	Agriculture
LUCKNOW		
37.	Central Drug Research Institute	CSIR
38.	National Botanical Research Institute	CSIR
39.	Industrial Toxicological Research Centre	CSIR
40.	Indian Institute of Sugarcane Research	ICAR
AGRA		
41.	Central Jalma Institute for Leprosy	ICMR

ALLEPPEY		
32.	Central Coir Research Institute	Industrial Development
ANANTAPUR(A.P)		
33.	Oil Technological Research Institute	CSIR
BHAVNAGAR		
34.	Central Salt & Marine Chemicals Research Institute	CSIR
BHUBANESHWAR		
35.	Regional Research Laboratory	CSIR
CALICUT		
36.	Central Plantation Crops Research Institute	ICAR
CHINGLEPUT		
37.	Central Leprosy Teaching and Research Institute	Health & Family Welfare
COCHIN		
38.	Central Marine Fisheries Research Institute	ICAR
COIMBATORE		
39.	Sugarcane Breeding Institute	ICAR
CUTTACK		
40.	Central Rice Research Institute	ICAR
DHANBAD		
41.	Central Fuel Research Institute	CSIR
IZZATNAGAR		
42.	Indian Veterinary Research Institute	ICAR
JAMMU		
43.	Regional Research Laboratory	CSIR

JODHPUR		
44.	Central Arid Zone Research Institute	ICAR
JORHAT		
45.	Regional Research Laboratory	CSIR
46.	Tockalai Experimental Station (Tea Research Association)	CSIR
KASARGOD		
47.	Central Plantation Crops Research Institute	ICAR
KARNAL		
48.	National Dairy Research Institute	ICAR
MALPURA		
49.	Central Sheep & Wool Research Institute	ICAR
MYSORE		
50.	Central Food Technological Research Institute	CSIR
NAGPUR		
51.	National Environmental Engineering Research Institute	CSIR
52.	Central Institute of Cotton Research	ICAR
PONDICHERRY		
53.	Vector Control Research Centre	ICMR
RISHIKESH		
54.	Indian Drugs & Pharmaceuticals Ltd.	Chemicals & Fertilizers
SIMLA		
55.	Central Potato Research Institute	ICAR

TRIVANDRUM

56.	Regional Research Laboratory	CSIR
57.	Central Tuber Crops Research Institute	ICAR

VADODARA

58.	Alembic Chemicals Works Co.Ltd.	Chemicals & Pharmaceuticals
59.	Sarabhai Chemicals	Chemicals & Pharmaceuticals
60.	Sarabhai Research Centre (Drugs & Pharmaceuticals)	Chemicals & Pharmaceuticals

LIST OF UNIVERSITIES & INSTITUTIONS OF NATIONAL IMPORTANCE IN INDIA (AS ON 1.10.1981)

	Name of University	Location
1.	Aligarh Muslim University	Aligarh (U.P.)
2.	Guru Nanak Dev University	Amritsar (Punjab)
3.	Gujarat Agricultural University	Banaskantha (Gujarat)
4.	Indian Institute of Science	Bangalore(Karnataka)
5.	University of Calcutta	Calcutta (W.B.)
6.	Jadavpur University	Calcutta (W.B.)
7.	Panjab University	Chandigarh (Punjab)
8.	Postgraduate Institute of Medical Education & Research(N)	CHANDIGARH(Punjab)
9.	University of Delhi	Delhi
10.	Jawaharlal Nehru University	Delhi
11.	Indian Agricultural Research Institute	Delhi
12.	All India Institute of Medical Sciences	Delhi
13.	Indian Institute of Technology (N)	Delhi
14.	Haryana Agricultural University	Hissar(Haryana)
15.	Osmania University	Hyderabad(A.P.)
16.	University of Kalyani	Kalyani (W.B.)
17.	Indian Institute of Technology	Kharagpur(W.B.)
18.	Punjab Agricultural University	Ludhiana(Punjab)
19.	Perarignar Anna University of	Madras (T.N.)
20.	Madurai Kamaraj University	Madurai(T.N.)
21.	Govind Ballabh Pant University of Agriculture & Technology	Pantnagar (U.P.)

22.	University of Poona	Poona (Maharashtra)
23.	Viswa Bharati	Shantiniketan(W.B).
24.	Sri Venkateswara University	Tirupati(A.P.)
25.	Banaras Hindu University	Varanasi(U.P.)